

MORTH ATLANTIC REGIONAL WATER RESOURCES STUDY COORDINATING COMMITTEE
MAY 1972

The North Atlantic Regional Water Resources (NAR) Study examined a wide variety of water and related land resources, needs and devices in formulating a broad, coordinated program to guide future resource development and management in the North Atlantic Region. The Study was authorized by the 1965 Water Resources Planning Act (PL 89-80) and the 1965 Flood Control Act (PL 89-298), and carried out under guidelines set by the Water Resources Council.

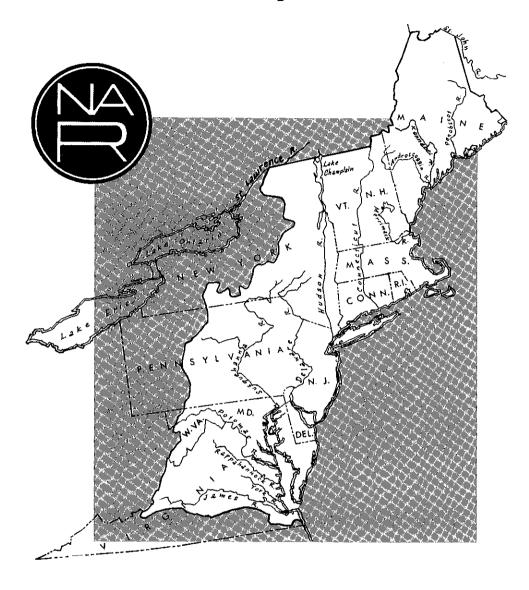
The recommended program and alternatives developed for the North Atlantic Region were prepared under the direction of the NAR Study Coordinating Committee, a partnership of resource planners representing some 25 Federal, regional and State agencies. The NAR Study Report presents this program and the alternatives as a framework for future action based on a planning period running through 2020, with bench mark planning years of 1980 and 2000.

The planning partners focused on three major objectives -- National Income, Regional Development and Environmental Quality -- in developing and documenting the information which decision-makers will need for managing water and related land resources in the interest of the people of the North Atlantic Region.

In addition to the NAR Study Main Report and Annexes, there are the following 22 Appendices:

- A. History of Study
- B. Economic Base
- C. Climate, Meteorology and Hydrology
- D. Geology and Ground Water
- E. Flood Damage Reduction and Water Management for Major Rivers and Coastal Areas
- Upstream Flood Prevention and Water Management
- G. Land Use and Management
- H. Minerals
- I. Irrigation
- J. Land Drainage
- K. Navigation
- Water Quality and Pollution L.
- M_o Outdoor Recreation
- Visual and Cultural Environment N.
- Fish and Wildlife 0.
- Ρ. Power
- Erosion and Sedimentation Q.
- R. Water Supply
- Legal and Institutional Environment S.
- T. Plan Formulation
- U. Coastal and Estuarine Areas
- V. Health Aspects

Appendix L Water Quality and Pollution



Prepared by

Water Quality Office Environmental Protection Agency

for the

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY COORDINATING COMMITTEE

North Atlantic Regional Water Resources Study

Appendix L

Water Quality and Pollution

Editor's Note

This final report of Appendix L includes all written recommended changes received as of May 1972. Due to the deadline for publication no attempt was made to redraft any substantial sections of the report.

The reader should realize that this report was written as a Type I study and cannot provide the detailed data on which to base specific abatement or enforcement actions.

APPENDIX L WATER QUALITY AND POLLUTION

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NORTH ATLANTIC REGION CHAPTER 1

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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY

APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 1

NORTH ATLANTIC REGION

ENVIRONMENTAL PROTECTION AGENCY WATER PROGRAMS OFFICE May 1972

I. INTRODUCTION

Authority

The North Atlantic Region is one of eighteen covering the United States as delineated in the Water Resources Council's program of comprehensive water and related land resource framework studies inaugurated by President Kennedy in response to the January 1961 report of the Senate Select Committee on National Water Resources. The North Atlantic Regional Framework Study was initiated in fiscal year 1966, following the approval of supplemental appropriations by the Congress and the President. The Corps of Engineers, U.S. Army was designated as the lead agency to coordinate the study.

The Division of Water Supply and Pollution Control, Public Health Service, U.S. Department of Health, Education and Welfare, at the request of the Corps of Engineers, prepared a plan of study to embrace the water supply and water pollution control problems in the Region, and agreed to prepare Appendices R and L to the NAR report, which cover water supply and water pollution, respectively.

Public Law 89-234, the Water Quality Act of 1965, created the Federal Water Pollution Control Administration in the U.S. Department of Health, Education, and Welfare, and transferred to the Administration the responsibility for carrying out the Federal water pollution control program, except for public health aspects relating to water pollution, which remained the responsibility of the Surgeon General. On May 10, 1966, the Administration was transferred to the U.S. Department of the Interior by Presidential Reorganization Plan No. 2 of 1966. The Water Quality Improvement Act of 1970, Public Law 91-224, Sec. 110, changed the Administration's name to Federal Water Quality Administration. On December 2, 1970 the Federal Water Quality Administration was moved from the Department of the Interior to the Environmental Protection Agency as the Water Programs Branch of the Air and Water Division.

Upon its establishment, the Federal Water Pollution Control Administration assumed lead responsibility for preparation of Appendix L, "Water Quality and Pollution", following plans of study previously developed. The Corps of Engineers assumed lead responsibility for preparation of "Municipal and Industrial Water Supply", Appendix R.

This report, Appendix L to the NAR Report, has been prepared under the authority of Section 3(a) of the Federal Water Pollution Control Act, as amended, and in accordance with the directives of the Water Resources Council. This report has been submitted to the Corps of Engineers by the Office of Water Programs of the Environmental Protection Agency.

Purpose and Scope

The purpose of Appendix L is to present a summary of present and future water quality problems and control needs in the NAR Study Area, so as to permit development of a framework plan cognizant of these problems and embracing needed pollution abatement activities. The framework plan is to be developed from three alternatives; one each to maximize Economic Efficiency, Regional Development, or Environmental Quality.

Appendix L is intended to reflect both Engineering and Institutional (Political) viewpoints and points out those conflicts which hamper water pollution control and water resource development as well as pointing out the needs for controlling pollution. In the Subregional Chapters 2-7 water quality problems are identified in Section VI, water use in Section IV, and waste sources and approximate waste loadings are presented in Section V.

Acknowledgements

The various regional and field offices of the Federal Water Quality Administration have prepared the several subregion chapters of Appendix L. The various Federal agencies cooperating in this study have supplied additional pertinent data to this agency. The Federal agencies, the 13 State agencies, and the several Interstate Commissions have all been requested to review the draft report and offer their comments.

II. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

- The water resources of the NAR are presently being used for various and, in many instances, conflicting purposes. The use of these waters can generally be described within the following categories: municipal and industrial water supply, recreation, commercial fishing, commercial navigation, power generation, and irrigation.
- 2. The major water bodies in the NAR Study Area in the vicinity of population and industrial centers are seriously degraded by pollution.
- 3. Nearly 37 million of the 45 million 1960 population of the NAR Study Area are served by waste collection and treatment facilities. (See Table 5: Estimated Present Non-Industrial Discharges.)
- 4. The Non-Industrial waste load before treatment is expected to nearly double by the year 2020 (43,800,000 P.E.'s vs. 86,600,000 P.E.'s). It is expected that this same loading after treatment will decrease through time due to increased treatment; from 16,000,000 P.E.'s to 9,760,000 P.E.'s.
- The 1960 Industrial waste load to the waters of the NAR Study Area is estimated at 67,033,000 P.E.'s before treatment which is reduced to 40,100,000 P.E.'s after treatment. See Table 6 for the breakdown of the present waste load by major water-using industry groupings.
- The total industrial waste load before treatment is expected to increase nearly ten-fold from 67,033,000 P.E.'s in 1960 to 624,000,000 P.E.'s in 2020. The industrial waste load before treatment in the year 2020 will amount to nearly 90% of the total load generated.
- 7. The total waste load in 1960 was reduced by treatment nearly half, from 111,000,000 P.E.'s to 56,800,000 P.E.'s. Although the projected total waste load is expected to increase sevenfold by the year 2020 the total treated load is expected to increase only about one-third to 75,600,000 P.E.'s in 2020.
- 8. Waste load treatment that will conform to both effluent and instream quality requirements for the waters of the NAR will reduce the total waste load in 2020 from 710,000,000 P.E.'s to 75,600,000 P.E.'s. (See Table 6.)
- 9. Planning Area 13 waters currently receive the largest quantities of both non-industrial and industrial wastes in the entire NAR Study Area.

- 10. Water quality degradation in the NAR Study Area is due primarily to the volume of non-industrial and industrial types of organic waste loadings. Of the inorganic waste sources, sediment is considered the largest pollutant by volume. Another inorganic waste source, acid mine drainage, is particularly important in Subregions D, E and F. An overview of the agricultural pollutants is found in the attachment to Appendix L entitled "Agricultural Pollutants" by the U.S. Department of Agriculture.
- 11. Stormwater and municipal wastes are presently collected, transported and discharged through some 337 combined sewer systems which serve an estimated population of 17,200,000 persons or about 45 percent of the Subregion's entire sewered population.
- 12. It is a basic assumption of Appendix L that it is possible to design and implement, by the year 1980, the combined sewer control facilities needed in the NAR. This implementation would not be intended to control stormwater drainage. The one time cost of providing these control facilities by 1980 would be \$5.160 million.
- 13. It is estimated that the cost of providing secondary treatment facilities for the waste loads anticipated in the design years 1980, 2000 and 2020 will be \$6,130 million, \$14,600 million and \$27,900 million, respectively. This would be in addition to providing combined sewer control facilities by 1980 at a cost of \$5,160 million.
- 14. Treatment levels must be increased through the design years in the NAR to maintain or enhance the quality of the surface waters in a manner compatible with State and Federal Water Quality Standards.
- 15. Further study of the water bodies and pollution sources should be made in Subregions B, C and D. Type II data is warranted in the portions of these Subregions which will show substantial increases in population and industrial activity through the design years.
- 16. It is felt that Type II studies will aid in developing the following three items which were lacking to varying degrees during the initial FWQA data screening for Appendix L: 1) data accessibility, 2) adequate methodology to fill gaps in data availability, and 3) provision of adequate pollution control surveillance.
- 17. Increased training efforts will be needed to provide adequate programs of operation and maintenance at waste treatment plants as well as qualified treatment plant operators, laboratory control staff, and accurate data recorders.

- 18. Since the Appendix L NARS Methodology did not allow extensive studies of regionalization of collection and treatment facilities, studies should be done which could result in the determination of the most practical size and location of treatment systems for the current and future development in light of actual conditions.
- 19. Flow regulation as an alternative to waste treatment is not feasible in the coastal areas of the NAR. Treatment levels may well have to be tertiary or advanced waste treatment processes.
- 20. All existing sources of thermal pollution should be identified and determinations made of their effects on the aquatic environment.
- 21. Investigations should be made at a nationwide level to develop practical means of controlling boat pollution, surveys to determine the need for adequate disposal facilities at marinas, and completion of adequate legislation to control such pollution.
- 22. Further studies are needed to determine the quality and quantity of stormwater overflows, the extent to which such overflows degrade water quality, and the correctional systems required.
- 23. Studies and control programs are required to determine the extent of nutrient discharges to the surface waters and to reduce the quantities of nutrient materials discharged to the waters.
- 24. Coordinated programs should be developed to coordinate dredging activities with other water resources management plans.
- 25. An integrated system of handling water quality and water use data should be developed to make more of this data available at all levels of government. This type of system, perhaps based on the Environmental Protection Agency STORET program would make possible better interchange of knowledge and eliminate duplication of studies.
- 26. Existing legal mechanisms and institutional arrangements must be examined to determine their adequacy to deal with water quality problems on both a local and regional basis.
- 27. Plans should be developed in a manner that maximum water quality benefits will be realized.
- 28. In studies like the NAR Study, and in subsequent studies, every effort should be made to keep the public informed to stimulate their interest and to enlist their support for water resource

planning and management. Decisions that are in the best interest of the majority of the resident population depend on how well informed they are of the facts concerning the environment and the support or lack of it that they give specific programs.

III. STUDY AREA

A. LOCATION AND BOUNDARIES

The North Atlantic Regional Study Area is roughly 1,000 miles long from the northernmost tip of Maine to the southernmost boundary of the James River Basin in Virginia. Extending inland an average of 200 miles from the Atlantic Coast, it covers a land area of 167,456 square miles. See Figure I.

The geographic area to be encompassed by the North Atlantic Regional Study (NARS) includes all river basins draining into the Atlantic Ocean at points north of the Virginia-North Carolina State border, Chesapeake Bay, the Lake Champlain drainage within the United States, and the St. Lawrence River drainage south of the junction of the St. Lawrence River and the International Boundary. The States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, the District of Columbia and portions of the States of New York, Pennsylvania, Maryland, West Virginia and Virginia are included within the Study Area boundaries.

The major river basins are the St. John, Penobscot, Androscoggin, Merrimack, Connecticut, Lake Champlain, Hudson, Delaware, Susquehanna, Potomac, Rappahannock, York and James, but the problems of the entire area, basins both large and small, from their headwaters to their estuaries are within the purviews of this study. See Table L-2(R).

The Study Area was subdivided for purposes of this study into six subregions, each of which was in turn subdivided into a total of 21 water resource Planning Areas. These water resource Planning Areas were established by the NARS Coordinating Committee on the basis of county boundaries, rather than on a hydrologic or river basin approach, so as to utilize economic projections developed on a county basis by the Office of Business Economics (OBE) of the Department of Commerce. Wherever possible, grouping of whole counties were made to coincide with principal river basin systems.

B. PHYSICAL FEATURES

General Hydrology:

There are 28 major river systems in the Region. The location of these river systems are shown on Figure I and the drainage area sizes are shown in Table 2 of the Subregional Chapters. Included in the NAR is the largest river on the eastern seaboard; the Susquehanna, some 544 miles long and draining 27,400 square miles. The rivers all flow through the Appalachian Mountains or rise on its slopes. Most headwaters lie in rugged mountainous terrain covered with heavy forest growths.

FIGURE 1

MAP OF

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY AREA

(in pocket in back of book)

The terrain of the NAR is markedly varied. There is the low, flat coastal plain of New Jersey and Delaware, the rows of parallel ridges of the Watchung, Kittatinny, Blue Ridge, Shenandoah, Blue, Tuscarora, Tussey, and Allegheny Mountains, with intervening fertile valleys. There are the rounded peaks of the Catskills and the more massive uplift of the Adirondacks, the Green Mountains, and the White Mountains. In New York and New England is the sparsely settled, densely wooded area with many small lakes. See Appendices C and G of the NARS Report for further details on hydrology.

2. Climate:

The climate of the NAR can be described under two headings, oceanic and continental. The former is found through the coastal areas of New England, New York, New Jersey, Delaware, Maryland, and Virginia, and is characterized by humid summers, evenly spaced precipitation and a growing season of about 200 days per year. The precipitation in this coastal area averages from 40-48 inches per year and the average annual temperature ranges from 48°F to 57°F.

Moving inland there is a change to the continental type of climate where extremes of temperature are encountered in a single day. Precipitation tends to be lower, except in the mountains. In general, throughout the area, the major portion of the precipitation occurs in the warm season which is very advantageous for agriculture. The major floods of this region usually occur when the streams are high from the spring runoff and a storm of tropical origin moves in from the sea dropping its moisture load on an area already saturated.

C. WATER USES

The waters of the NAR are presently being used for many and, in some instances, conflicting purposes. The uses of these waters can generally be described within the following categories:

Municipal and industrial water supply Shellfish propagation
Recreation
Commercial fishing
Commercial navigation
Power generation
Irrigation
Wildlife and waterfowl habitat
Other

Future utilization of the surface waters will depend on their future water quality. The States evaluation of the desirable and present uses of a particular reach of water body control the

selection of the instream water quality criteria. It is likely that both the intended usage and the assigned criteria will change through time.

Information on the existing and anticipated use of these waters is contained in Table 4 of each Subregion chapter in Appendix L.

D. SOCIO-ECONOMIC CHARACTERISTICS (WATER QUALITY ORIENTED)

1. Introduction

The NAR includes the area known as "Megalopolis", a thickly settled strip of territory along the Atlantic coast, from Boston to Washington, where metropolitan centers are so numerous and so closely spaced that a majority of the land area and almost all of the population is either urban or suburbanized. Within this area lie the great commercial and industrial seaports of the east coast, and numerous smaller or inland metropolitan areas. There are many significant traits which set this Megalopolis apart from the rest of the NARS area and also from the rest of the United States. Twelve of the most important reasons are shown below.

- a. Great population size, high density, high degree of urbanization and suburbanization. In 1960, 36.5 million persons, or 20 percent, of the total American population, was living in this narrow strip of land. Thus, although it contains only about 1/60 of the land area of the Nation, this region contains 1/5 of the people.
- b. Reliance upon manufacturing as the major source of employment and livelihood. Almost one-third of the employed work force of this region is engaged in manufacture.
- c. Comparative absence of mineral and fuel resources and other raw materials. Manufacturers located in this region are in the anomalous position of having to import almost all of their raw materials from some place else - either from another region or from abroad.
- d. Brisk international trade, coastal shipping and port activity. New York City, Boston, Philadelphia, Wilmington, Baltimore, Norfolk, and Providence all have excellent harbors and major well-developed port facilities.

- e. Highly developed system of inland transportation, with easy access to all regions. All of the great transcontinental streams of rail traffic converge upon these east coast ports, and the east coast railroads are integrated with each other. Rapid highway transportation completes a system whereby any one metropolis can draw from any region. When added to the water transport facilities, the result is a very high degree of accessibility.
- f. Administrative and governmental control of economic activities throughout the Nation. A very large share of policy and other administrative programs and decisions of the Nation are devised and administered by organizations whose headquarters are located in this region.
- g. A manufacturing industry that is highly diversified, but which concentrates on consumers and nondurable goods. There is not a single major category of manufacture that is not found in substantial quantity in this region.
- h. A high concentration of professional, business and cultural activities. An above-average concentration of professional, medical, and business services is located in this region.
- i. A high proportion of foreign-born population and native-born population of mixed nationality.
- j. Sustained population growth. One somewhat surprising trait of the Atlantic Metropolitan Belt has been its ability to enjoy a steady and sustained population growth during the present century.
- k. High average incomes and high average level of living. In only two areas, the Lower Great Lakes area and the Pacific Southwest area is the income level unmistakably higher than in this region. In all of the other areas of the United States the income level is unmistakably lower.
- An agriculture highly specialized in cash crop, poultry, and dairy farming and organized for immediate sale of perishable farm products in metropolitan markets.

2. Region Summary

The entire NARS Area had a 1960 population of some 44,653,000 which is expected to nearly double to 86,365,700 by the year 2020. Table 3 shows selected economic measures for the benchmark years. It is noteworthy that total employment is also expected to nearly double from 18,409,995 in 1960 to 35,331,200 in 2020. On the other hand, employment in manufacturing, and especially employment in the six major water using industry SIC groups, will remain nearly constant through the benchmark years. The very generalized nature of this concept requires further identification at both a Subregional and Planning Area level. See the specific Subregion Chapters (Section III Economy, and Table -3) for greater specificity.

TABLE L-3(R)

SELECTED ECONOMIC MEASURES

REGION SUMMARY

ECONOMIC MEASURES	1960	<u>1980</u>	2000	2020
Population	44,653,000	55,713,200	69,736,900	86,365,700
Total Personal Income (\$000) (1958 Dollars)	107,810,000	253,798,735	587,962,304	1,149,971,197
Per Capita Income ^{a/} (1958 Dollars)	2,232	4,272	7,360	12,700
Total Employment	18,409,995	22,926,200	28,727,900	35,331,200
Agriculture + Forestry + Fisheries	400,306	280,800	206,500	149,100
Mining	52,977	24,300	19,400	16,300
Total Manufacturing	5,583,812	6,031,800	6,067,700	7,066,600
Six Major Water-using Industries Total	1,629,265	1,640,600	1,729,000	1,890,300
20 Food and Kindred Products 22 Textile Mill Products 26 Paper and Allied Products 28 Chemicals and Allied Products 29 Petroleum Refining 33 Primary Metals	458,553 324,177 207,272 308,644 59,576 271,043	412,700 222,500 248,700 415,100 36,400 295,300	401,200 160,400 287,500 540,700 27,000 312,255	386,900 88,000 334,800 694,800 21,200 332,800
All Other Manufacturing Employment	3,954,547	4,387,100	4,698,800	5,176,300
Armed Forces (number)	424,245	398,100	398,400	398,600
All Other Employment Categories	11,136,855	16,195,200	21,675,900	27,700,600

a/ Based upon 1959 population and personal income reported in 1960 Decennial U.S. Census.

Source: North Atlantic Regional Water Resources Study, Appendix B, Economic Base,

Prepared by Office of Business Economics, Regional Economics Division, U.S. Department of Commerce.

IV. METHODOLOGY AND RATIONALE

A. PLANNING AREAS

The Environmental Protection Agency input has been arranged by NAR Planning Areas which are 21 groupings of whole counties which most nearly approximate respective NAR hydrologic basins. Each Subregional Chapter contains a map designated Figure - 1 which shows the county and Planning Area lines superimposed upon the river basin outline. The utilization of boundaries on a county line and Planning Area basis permitted the utilization of economic data and projections developed on a county basis by the Office of Business Economics (OBE) of the Department of Commerce. In most cases Subregion division by Planning Areas rather than river basin boundary has not created significant allocation differences of large population centers and economic activity centers.

B. ECONOMIC PROJECTIONS

The development of future water quality control needs contained in this report utilized as base economic and population projections developed for NARS by the OBE. In its projections to the target years 1980, 2000 and 2020, which are presented in detail in Appendix B of the NARS Report, OBE has included both population growth and expansion of selected industry output on a county basis. These projections by counties were disaggregated and reassembled into NAR areas by the Corps of Engineers NAR Planning Group, and made available to EPA. In some instances where detailed Type 2 or other water resource studies have been underway or completed, projections utilized were not identical to the OBE projections developed for the NARS. In such cases, the most recent data were used. Where significant differences were found in the base projections of population and industrial output growth, both projections were used to give a range of needs for water quality control.

C. WATER USE DATA AND PROJECTIONS

Since water quality needs are tied closely to the uses to be made of a water, it was necessary to consider the present and future uses to be made in the NAR. Listings of present and projections of further uses were generated by other agencies. The needs most closely related to water quality control and the responsible agencies were as follows:

Municipal and Industrial Water Supply - Corps of Engineers Recreation - Bureau of Outdoor Recreation Fish and Wildlife - Bureau of Sport Fisheries and Wildlife Agricultural - U.S. Department of Health, Education and Welfare Hydropower - Federal Power Commission Aesthetics - Corps of Engineers

See these individual appendices and Appendix T for related information.

In developing water quality standards for interstate, and in many cases, intrastate waters, as discussed later in this report, the states conducted public hearings to determine the future uses to be made of the waters in the NAR. The water quality standards and criteria promulgated for each section of water body are based upon the highest anticipated usage of these waters. During the plan formulation stages of this study, the agencies listed above have stated that if water of a quality specified in the standards were provided, these needs could be met (assuming sufficient quantities are available). Accordingly, a basic assumption in this report is that satisfying the quality demands expressed in the water quality standards would provide a quality of water suitable for all projected needs. Thus man-made-environmental changes such as damming for flow augmentation are beyond the scope of Appendix L.

D. PRESENT AND FUTURE WASTE LOADINGS

In developing the immediate and long term water quality in the NARS area, EPA prepared estimates of both present and future waste loadings. Present waste loads were obtained from previously prepared studies, reports and inventories generally covering the period 1960-1967. Waste loads for future years 1980, 2000 and 2020 were then developed utilizing the known data and projections of growth supplied by OBE.

Estimates of wastewater loads were presented in terms of biodegradables only, as measured by biochemical oxygen demand (BOD). All waste loads were described in terms of population equivalents (PE's). By definition, a population equivalent is an amount of waste (here in terms of BOD) equal to that produced each day by one person. Where problems other than BOD were known or projected on the basis of current data, specific mention has been made in the text. Waste loads were assumed as coming from two types of sources, industrial and non-industrial. The latter term embraces all domestic and commercial wastes.

Within the NARS Area are more than two million separate housing units, as well as an unknown number of business establishments which dispose of waste through septic tanks or cesspools. While this form of disposal does not constitute a major problem in the NARS Area localized problems do occur. As the density of portions of the Area increases, the combined effects of these individual disposal systems will become increasingly unsatisfactory. Future implementation of

existing State legislation is expected to cause a significant drop in the percentage of individual systems in relation to the total population of the NARS Area.

Non-industrial waste loads before treatment for each target year were calculated from OBE population projections as disaggregated and reassembled into NAR areas by the Corps of Engineers. See Table 5: Estimated Non-Industrial Discharges, and Table 6: Estimated Present Industrial Wastes. Projections for Subregion A used data provided by the Corps in December, 1968; those for all other Subregions utilized the August 1968 data from the Corps. In developing the future non-industrial loads, it was assumed that the entire projected population for each target year would be served by collection and treatment facilities.

Projected industrial waste loads were estimates of the total BOD generated by an entire two digit SIC group in an area. Projections were made for the six major water using industries; SIC codes 20, 22, 26, 28, 29, and 33. An additional category, "All Other" was used to include all potential industrial BOD loads from industries not represented in the six selected SIC groups.

Future industrial loads were estimated by applying an output index to the known 1960 loadings. In general, this output index was provided by Cornell University in August 1968, and incorporated both projected employment by water resource planning area and projected productivity (output per employee) by OBE economic area. However, in selected areas where projections by OBE differed significantly from projections developed by more detailed studies, the more detailed projections were utilized. This was done in the James, Susquehanna and Potomac River basins.

The Projected total waste load in PE's before treatment for each area (1-21) was determined for each target year by summing the industrial and non-industrial loads. This total load was used to estimate treatment needs and residual loads to the basin, the capital cost of treatment facilities, and the need for additional measures. All such projections were done on an untreated (raw) waste basis. In determining loads to the stream, assumptions were made on the future treatment which would be provided.

For the base year, 1960, the treatment provided was that actually known to exist. For the year 1980, it was assumed that all wastes would receive secondary treatment that would provide 85% removal of BOD (as PE's) and 90% removal of suspended solids. Recognizing the likelihood of increasing treatment efficiencies, for the years 2000 and 2020, these removals were increased to 90% BOD and 95% suspended solids.

Where further treatment beyond secondary was indicated, such treatment was described as either "tertiary" or "advanced waste treatment" (AWTR).

E. EFFECTS OF WASTE ON WATER QUALITY

The waters of the North Atlantic Region receive wastes containing a variety of pollution substances. The resulting degradation of the waters can prohibit recreation, increase the cost of water treatment for domestic or industrial uses, impair the survival of fish and wildlife, destroy aesthetic values, cause corrosion of structures exposed to water and generally make the receiving waters less useable to man and his environment. These polluting substances can be classified in seven general categories: 1) oxygen demanding wastes; 2) infectious agents; 3) plant nutrients; 4) heat; 5) organic chemicals; 6) sediments; and 7) other mineral and chemical substances. A general discussion of these seven categories follows.

Oxygen demanding wastes include putrescible organic substances which can be broken-down generally by aerobic bacterial action, to more stable compounds. In this process a portion of the dissolved oxygen normally found in the receiving waters is consumed. Oxygen transferred from the atmosphere or generated by photosynthetic activity of aquatic plants can replace the oxygen utilized by bacteria during stabilization process. However, when the waste load uses oxygen faster than the rate at which oxygen is replenished in the stream, the dissolved oxygen level in the stream is reduced to below acceptable minimum levels. Desirable forms of biological organisms are replaced by more tolerant species. When oxygen is completely depleted (anerobic conditions), the waters become dark in color and obnoxious gases are produced (septic conditions). Fish and other desirable aquatic organisms perish, the stream becomes worthless for virtually all uses, and a public nuisance exists.

The amount of oxygen required to stabilize the organic material present is measured by the 5-day biochemical oxygen demand (BOD) test. Under normal conditions, the BOD of human municipal waste is 0.17 pounds of oxygen per person per day, and a unit of waste exerting this demand is defined as one population equivalent (PE). This definition is used in describing the oxygen demand of both municipal and industrial waste loads in this report.

Infectious agents are disease-causing organisms. Such agents are found in human sewage conveyed in municipal waste systems and in the wastes from certain industries, such as slaughter houses and tanneries. These organisms can cause a wide variety of bacterial and viral diseases, such as typhoid fever, intestinal disorders,

and infectious hepatitis in human beings, either by direct ingestion as in the case of water supplies or by contact experienced through recreational or other activities. The presence of such wastes in surface or ground waters constitutes a hazard to health and restricts the use of that water for water supply and recreation.

The coliform group of bacteria which is found in the fecal matter of all warm-blooded animals, including man, is most commonly used to define bacterial contamination. These organisms may also be found in plants and soil, but their presence above certain limits in water is, however, generally considered evidence of fecal contamination and is an indication that a health problem exists.

Plant nutrients are mineral substances in solution which are necessary for plant growth, but which in excess amounts can over stimulate the growth of algae and other aquatic plants. growth of these plants, which can be of the unicellular, filamentous, or rooted variety, can often upset the balance of a natural aquatic environment. The extensive growth of aquatic plants, such as that which occurs in an algal bloom, can cause taste and odor problems in water supplies, and eliminate aesthetic and recreational values of the waters by reducing their clarity, and entangling swimmers and boaters. When aquatic plants die and decompose, their organic matter imposes an oxygen demand. In a normal balanced environment, this demand is offset by the production of oxygen by photosynthesis during daylight hours. The decay of excess growths, particularly during hours of darkness, can utilize more oxygen than is produced, dropping the dissolved oxygen levels to below that needed to sustain desirable life forms. In addition, certain types of algae produce toxins, or toxic substances. In blooms of such algae, the high output of toxins can cause problems in water supply, and may result in the death of aquatic animals as well as the wildlife and farm animals who consume such waters.

There are over 20 elements necessary as nutrients for aquatic plant growth, but nitrogen and phosphorous appear to be the two major limiting elements normally found in natural waters. The addition of excess amounts of these elements to a water body by the discharge of municipal and industrial waste, the direct discharge from vessels, overland runoff from farmlands exposed to chemical fertilizers, and percolation from septic tanks and cesspools, may be sufficient to enrich (eutrophy) the receiving waters, resulting in the excessive growths.

The discharge of cooling water from fossil and nuclear electric generating plants and certain industrial establishments can add substantial amounts of heat to the receiving water. The resulting increase in water temperature can have several adverse affects on water quality, particularly during the summer months when the stream flow is low and the prevailing water temperature high.

The maximum amount of oxygen (saturation value) that can be dissolved in water depends in part on the water temperature. As the temperature increases, this saturation value is decreased, and the water has less oxygen available to assimilate oxygen demanding wastes. Water temperature is also a critical factor in the survival of fish and other aquatic life. An increase of a few degrees in temperature can interfere with reproduction and migration, and accelerate disease, while a substantial temperature rise can virtually eliminate all aquatic life. High temperatures can also accelerate bacterial activity and stimulate the productivity of algae and other aquatic plants.

Organic chemicals are such complex materials as household and commercial detergents, insecticides, and herbicides. Such materials are conveyed to the receiving waters by municipal sewers, industrial waste discharges and land runoff. The presence of even very low concentrations of these chemicals can have a detrimental affect upon water quality. Such substances can add taste and odor to the water, create the tainting of fish flesh and interfere with water treatment processes. Most importantly, many of these materials are toxic to aquatic life. The total affect of these chemicals upon human beings, animals and fish and wildlife is little understood, but many have an immediate toxic affect, as displayed by the numerous fish kills reported throughout the region. Others may destroy one part of the food chain, leading to the ultimate death of higher species of life.

Sediment consists mainly of soil and mineral particles that are washed into the water from the land by storms and flood waters. These materials may be inert solids such as clays or organic in nature. The inert solids do not take part in chemical reaction, but affect water quality and the natural biota in a number of ways. The larger sized particles settle to the bottom and blanket aquatic life, hindering fish production by destroying spawning grounds and the necessary food chain organisms. Such sediments also fill navigable channels and reservoirs.

Sediments in suspension reduce the amount of light below that required by aquatic plants which, while it may aid in maintaining the dissolved oxygen concentration of the water by preventing algal blooms, may also interfere with the food chain. Sediments also interfere with water treatment processes and cause increased treatment costs. In addition to these affects, organic sediments may produce an oxygen demand.

A large number of other mineral and chemical substances resulting from various mining and industrial processes enter the waters of the Region. These substances include salts, metals and metal compounds, acids and a wide variety of manufactured chemicals, many

of which have a toxic effect. Mine drainage discharges, which are in this category, are of particular importance in the Region. discharges are highly acid and contain high concentrations of inert sediments and heavy metals such as iron and manganese. degraded by mine drainage are often sterile, i.e., unable to support any forms of aquatic life. Game fish and the other desirable aquatic organisms are usually the first to be seriously affected. Mine drainage also destroys the microscopic bacteria needed to stabilize the organic matter that may enter the water. structures are eroded and metal structures corroded. Water treatment processes such as chemical coagulation, softening and corrosion control are affected by the constituents found in mine drainage. The precipitation of iron salts stain household plumbing fixtures and interfere with industrial processes. Acid mine drainage also increases the hardness and mineral content of the water, thereby making water treatment expensive and difficult.

F. DETERMINATION OF WATER QUALITY PROBLEMS

To establish the nature and extent of both present and future water quality problems, each Subregion and where necessary, each water resource Planning Area, was examined for the magnitude and type of waste loadings. The present condition of the receiving water was evaluated and an estimate made of its probable condition after provision of adequate treatment. Where adequate data were available, this estimate was developed using available mathematical models. Streams where such techniques could be applied are identified in later sections of this report.

In general, however, available data did not permit such detailed evaluation. In such cases it was assumed that by 1980 all waste sources would receive secondary treatment, and that the resulting water quality would be at least equal to that called for by State and Federal Water Quality Standards.

Each of the Subregion Chapters contains a map titled "Water Quality Problem Areas" for the specific Subregion. Zones of possible water quality problems are shown for significant water bodies in each Subregion. The red overlay indicates municipal and/or industrial waste effects while present or potential thermal pollution areas are shown in green.

In each Subregion Chapter, Table - - 8: "Known Water Pollution Problems" indicates the major bodies of water in the Subregion and further indicates if specific pollution problems are known to exist on any reach of water so named. The types of problems identified are: non-industrial, industrial, thermal, septic tanks and cesspools, navigational, acid mine drainage, combined sewer systems, nutrient enriched water, and inadequate dilution.

In projecting stream conditions to the target years 2000 and 2020, available Type 2 studies were utilized. In those Planning Areas where detailed studies were not available, residual stream loads after secondary treatment in the year 2000 and 2020 were compared with the 1980 load after secondary treatment, except for Planning Areas 14 and 15. If the residual load was more than twice that for 1980, it was assumed that tertiary treatment, AWTR or stream flow augmentation would be required. If the 2000 or 2020 load was greater than that of 1980 by less than a factor of two, the need for detailed study was pointed out. The selection of AWTR versus tertiary was made on the basis of judgment of the problems in each Planning Area.

In Planning Areas 14 and 15, the same procedures were followed except that in lieu of 1980 as a base year, stream loadings were compared to a synthetic 1960 load derived by assuming 85% BOD removal for all known 1960 waste loads.

G. POLLUTION CONTROL MEASURES

In the final analysis, the residents of the NAR must decide what use is to be made of their resources. Whether or not the decision that is reached is in the best interest of the majority of the residents depends on how well informed they are of the facts concerning the environment and the consequences of their decision or their indecision.

The environment, in which and from which everyone derives existence, has been or is being destroyed by improper utilization. Past damage has been allowed to happen largely because of public apathy, lack of adequate pollution control programs, and the shortsighted desire for quick and easy monetary gain. Many of the environmental problems in Subregion C are the legacy of past industrialization. By the proper planning actions we must insure that similar charges cannot be leveled at our efforts.

The most effective method of protecting the water quality of the NAR is to prevent pollutants from entering the water. The reduction of the waste loads, the reduction of wastewater volumes, and the alteration of waste load characteristics at their source are some of the methods which can simplify water pollution abatement and control.

Wastewater from non-industrial and industrial sources generally contains large amounts of pollutional material which is biodegradable. Even with the implementation of all feasible source control measures, many wastes still must be treated to ensure adequate assimilation of such wastes by the receiving water without adverse

effects upon any other water use. Projections of population and employment indicate organic waste loads will cause contravention of Water Quality Standards unless adequate treatment measures are provided.

A number of treatment methods and alternatives are available. In this study, secondary, tertiary and advanced waste treatment as well as flow regulation (specifically low flow augmentation) are considered. See the individual Subregional chapters:
Section VII, Pollution Control Methods, for further and more detailed discussion. For the purpose of the NARS, complete replacement of the wastewater treatment facilities has been assumed to be needed every 20 years. This is done in light of Type I study data with the recognition that portions of any facility may indeed have a useful life of less than or greater than 20 years but would be eventually replaced.

It is also recognized in this study that there are portions of the NARS Area which are infeasible to treat through the design years by connecting the various point sources of pollution to a wastewater treatment facility. An example of this would be an area where houses are located too far apart to justify a municipal collection and treatment system.

H. COSTS

Capital treatment costs were developed on an area basis and should be regarded as order-of-magnitude values only. Costs were developed using data from EPA files and two publications: "Cost of Clean Waters", FWPCA, 1968; and "A Compilation of Cost Information for Conventional and Advanced Wastewater Treatment Plants and Processes" by R. Smith, FWPCA, Cincinnati, Ohio, 1967. In estimating capital costs, an assumed plant life of 20 years was used, and hence the estimates for each target year include complete replacement costs for all plants. Unless otherwise stated in the Subregion Chapters the costs identified do not include costs for collection system, interest, operation and maintenance, combined sewer reparation or control, etc. Costs for these items are under study.

The number, type, and size of wastewater treatment facilities required was developed by choosing a design size facility range equal to that of each Planning Area's municipality population size range and then taking an average \$ figure of that range based upon the degree of treatment thought to be required. For the purposes of this Appendix, no regionalization of treatment systems was assumed since this would require an in-depth study of local conditions. The development of multiple collection systems and single point treatment facilities could effectively reduce the reported estimated costs shown in Tables 9.

The "estimated cost of secondary treatment" as shown in Table L-9(R): Projected Capital Costs of Water Quality Control is determined for each Planning Area by multiplying the figure for the Total Waste Load in P.E. from Tables 7 by the appropriate dollar cost per P.E. (variable by Planning Area, \$18-63) 1/2 and summing to Region Total. To obtain a different cost caused by a change in population or employment, one can work backward; calculate the appropriate dollar per P.E. cost by dividing the secondary treatment costs listed in Tables 9 by the total loads in P.E.'s for each Planning Area given in Tables 7.

For treatment levels beyond secondary treatment, where required, a dollar cost of \$6 per P.E. was multiplied by the total waste load before treatment in P.E.'s for each Planning Area and summed to Subregion or Region totals. This cost is incremental to the secondary treatment level costs.

Annual costs were not provided for the Work Plan Formulation or in the Tables 9 on Projected Capital Costs. However, operating and maintenance costs, study and implementation costs, and finance charges will total an amount approximately equal to that value obtained as cost of secondary treatment. Thus, annual costs, not including principal reduction, can be derived by dividing the target year secondary treatment costs by 20 years excluding replacement costs.

The cost of combined sewer flow control was obtained by multiplying a factor of \$300 per P.E. by the number of people being served by combined sewers. Where information was not available as to the number of people in a Planning Area served by combined sewers, a value of 80% of the total population served was used for Subregions A and B and 50% was used to determine this number in Subregions E and F. These were considered to be one time costs to be spent by 1980. Any new sewer construction would then eliminate the old combined sewers and not contain any new ones.

Stormwater flow costs and flood control flow costs were not reported in this Appendix.

Acid mine drainage control costs were done by Subregion and were derived from studies made by the Bureau of Mines, the State Mining Control Boards and the FWOA Middle Atlantic Region Office in Charlottes-ville, Virginia (now EPA, Philadelphia, Pennsylvania).

It is felt that the costs given in this Appendix cannot be totalled directly since they would not give an accurate picture of actual progress in expenditures. The costs are however useful as orders of magnitude to weigh the alternate choices of decisions that must be made.

^{1/} Source: p. 15, Table 5, Sewage Treatment Works Construction per Capita Cost, The Cost of Clean Water, Volume 1, Summary Report, FWQA, 1968.

TABLE L-9(R)

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL^a/
REGION SUMMARY^e/

	Estimated Cost of	Estimated Addi- tional Cost of	
Year	Secondary _b /	Advanced Waste Treatment	Other Cost <u>d</u> /
	SUB	REGION A	-
1980	\$ 244,000,000		\$ 76,000,000
2000	477,000,000	\$ 239,000,000	
2020	882,000,000	445,000,000	
	SUB	REGION B	
1980	878,000,000		1,560,000,000
2000	1,510,000,000	232,000,000	
2020	2,370,000,000	368,000,000	
	SUB	REGION C	
1980			2 200 200 200
	1,610,000,000		2,200,000,000
2000	3,510,000,000	410,000,000	
2020	6,100,000,000	900,000,000	·
	SUB	REGION D	
1980	1,870,000,000	225,000,000	547,000,000 <u>e</u> /
2000	6,190,000,000	930,000,000	
2020	13,100,000,000	1,760,000,000	

TABLE L-9(R) (Cont'd)

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL^a/ REGION SUMMARY^e/

Year	Estimated Cost of Secondary _b / Treatment—	Estimated Addi- tional Cost of Advanced Waste Treatment BREGION E	Other Cost_
	501	BREGION E	
1980	\$ 616,000,000	\$ 40,400,000	
2000	996,000,000	64,900,000	
2020	1,660,000,000	178,000,000	
	SU	BREGION F	
1980	913,000,000		
2000	1,890,000,000		
2020	3,830,000,000		
	REG	ION TOTAL	
1980	6,130,000,000	265,000,000	\$4,380,000,000
2000	14,600,000,000	1,880,000,000	
2020	27,900,000,000	3,650,000,000	

- <u>a/</u> For general purpose planning only. Based on 1960 dollars. Costs not to be applied to any individual situation.
- b/ Based on treating organic waste loads of both industrial and domestic origin. Treatment is considered to be 85% removal for the year 1980 and 90% for the years 2000 and 2020.
- C/ Treatment which would remove, in addition to 95% Biochemical Oxygen Demand and 98% suspended solids, up to 98% of nutrients and up to 95% of other materials not removed by conventional treatment methods.
- These costs are, where known, estimates for combined sewer overflows control.
- e/ Partial figures may not add to totals because of independent rounding off of numbers.

V. WATER QUALITY CONTROL

The wastewaters being discharged to the waters of the NAR Study Area are considerable in volume and strength. Essentially all of the major waters receive municipal, industrial, agricultural or all types of wastewater. Untreated, partially treated and treated wastes from non-industrial and industrial sources amounting to 57,000,000 P.E.'s of BOD is presently being discharged to these waters.

A. PRESENT NON-INDUSTRIAL AND INDUSTRIAL WASTE LOADS

Presently, 2300 known municipal, institutional and Federal sources discharge wastes which exert a biochemical oxygen demand of approximately 16,400,000 P.E.'s. Of the total Region population, 83 percent, or 36.8 million persons, was served by wastewater collection systems. Of this population's wastewater, about 12 percent was discharged to receiving waters untreated, 48 percent was given at least primary treatment and 40 percent was given secondary treatment or better. The remaining 17 percent of the region's population was either using individual disposal systems such as septic tanks and cesspools (6.0 million persons) or had to be classified as unknown (1.8 million persons). See Tables 5: Estimated Present Non-Industrial Discharges, for both Subregional and Regional data.

Industrial discharges, consisting of wastes from all the major water-using industries, contribute 40,000,000 P.E.'s of BOD or about 70 percent of the total discharged load. The pulp and paper industry accounts for approximately 35 percent. An equivalent percentage comes from non-industrial sources making these the two largest contributors to organic pollution in the Region. Table 6: Estimated Present Industrial Wastes has been compiled by Planning Area in each Subregional Chapter and by Subregion and Region in Chapter I and indicates the waste loading by industrial group of water-using industries.

In addition, industries such as the chemical, petroleum, paper, primary metals and mining operations which produce inorganic wastes discharge to the Region's waters. It is, however, beyond the scope of this study to determine the magnitude of these inorganic wastes or their effects on receiving waters. Effects of erosion and sedimentation due to land and channel conditions are covered in Appendix Q, "Erosion and Sedimentation".

TABLE L-5 (R)

ESTIMATED PRESENT NON-INDUSTRIAL DISCHARGES*

REGION SUMMARY

		מ	EGRI	EE O	FTRE	ATME		Systems	Systems	Combined
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated	Not Chlor- inating	Storm- Sewer Systems
<u>A</u>										
Number of Systems Pop. Served (000)	182 341	18 4	138 272	18 49		8 16			177 315	56 256
Waste Load Disch. Calc. P.E. (000)	306		272	32		2				
<u>B</u>										
Number of Systems Pop. Served (000)	587 7,020	2	295 1,220	149 4,390	1	137 1,400	3 6		418 2,830	160 5,190
Waste Load Disch. Calc. P.E. (000)	4,280		1,220	2,850		211				
<u>c</u>										
Number of Systems	486	28	155	193	29	76	7	66	200	92
Pop. Served (000)	11,600	11	1,910	1,630	2,460	5,540	11	3,000	5,010	7,350
Waste Load Disch. Calc. P.E. (000)	4,780		1,910	1,060	982	826				
<u>D</u>										
Number of Systems Pop. Served (000)	494 10,900	41 204	58 206	119 6,360	20 57	255 3,960		47 2,355	25 1,750	29 4,410
Waste Load Disch. Calc. P.E. (000)	3,860		206	4,130	23	594				

^{*}Includes waste loads from municipalities, institutions and Federal installations.

Totals may not agree due to independent rounding off of numbers.

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TABLE L-5(R) (Cont'd)

ESTIMATED PRESENT NON-INDUSTRIAL DISCHARGES*

REGION SUMMARY

		D	EGR	EE O	F TRI	EATMEI		Systems	Systems Not Chlor- inating	Combined Storm- Sewer Systems
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated		
<u>E</u>										
Number of Systems Pop. Served (000) Waste Load Disch.	362 3,710		131 703	106 847	4 17	121 2,060				
Calc. P.E. (000)	1,640		703	616	7	309				
<u>F</u>										
	206		20	50		1.00				
Number of Systems Pop. Served (000) Waste Load Disch.	206 3,290		38 48	59 1,210		109 2,010				
Calc. P.E. (000)	1,570		48							
Region Total										
Number of Systems	2,320	89	815	644	54	706	10	113	820	377
Pop. Served (000) Waste Load Disch.	36,800	219	4,360	14,600	2,530	15,000	17	5,360	9,900	17,200
Calc. P.E. (000)	16,400		4,360	8,690	1,010	1,940	-			

^{*}Includes waste loads from municipalities, institutions and Federal installations.

Totals may not agree due to independent rounding off of numbers.

B. PROJECTED NON-INDUSTRIAL AND INDUSTRIAL WASTE LOADS

Future generated untreated organic waste loads will increase to 199 million P.E.'s in 1980, 371 million in 2000, and 705 million in 2020. With a secondary level of treatment these loads would be reduced to 30 million P.E.'s in 1980, 40 million in 2000, and 75 million in 2020 which would then be discharged to the waters of the Region. By the year 2020, industrial wastes will account for over 85 percent of the total organic waste load.

Tables 5, 6, and 7 summarize the present and future organic waste loadings in the Region.

C. COMBINED SEWER SYSTEMS

Stormwater and municipal wastes are presently collected, transported and discharged through at least 337 combined sewer systems within the Region. These systems serve an estimated population of 17.2 million persons or approximately 45 percent of the Region's entire sewered population. The metropolitan planning areas, especially Numbers 9, 13, 14 and 15, having the largest concentrations of people and the oldest wastewater collection systems have the most acute problems with these systems. The above numbered planning areas account for 13.9 million persons served by combined sewer systems.

Data is unavailable to accurately estimate the amount of wastewater discharged by these systems. For the purposes of this study, it is assumed that combined sewers will decrease to less than present levels through the design period.

D. SEPTIC TANKS AND CESSPOOLS

Within the Region there are more than 1.5 million separate housing units, as well as an unknown number of business establishments, which dispose of waste through septic tanks or cesspools. As the densities of the Region's localized populations increases, these individual disposal systems will become increasingly unsatisfactory.

It is expected that through the design period there will be a significant drop in the percentage of individual systems in relation to the total sewered population. Notable exceptions would be recreational development areas and lightly populated rural areas.

TABLE L-6 (R) ESTIMATED PRESENT INDUSTRIAL WASTES REGION SUMMARY

	2 D1	git SIC Group	Waste Load Before Treat. 1/ (Est. P.E.)	Number of Known Sources	W None		QUACY TREAT Complete		Discharged 2/ Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
	20	Food Water Use MGD	10,200,000	442	138	221	19	64	5,680,000	SS ^{3/} ,Grease,Oil, Disease-Bacteria
	22	Textiles Water Use MGD	9,720,000	265	216	31	7	22	4,190,000	SS, Color
	26	Paper Water Use MGD	27,900,000	220	107	80	7	19	19,700,000	SS, Color, pH
L-33	28	Chemicals Water Use MGD	9,100,000	199	70	79	23	32	4.960,000	SS, Color, Oil, pH, Grease, Toxic Materials
w	29	Petroleum Water Use MGD	5,280,000	32	16	17	2	8	2,520,000	SS, Oil, Grease
	33	Primary Metals Water Use MGD	1,420,000	241	167	45	5	24	569,000	Toxic Metals, pH, SS, 011
	10 -	14 Mining Water Use MGD	3,000	43					2,000	Acid, Sediment
	хх	Other Indus. Groups Water Use MGD	3,410,000						2,480,000	
		Region Total Water Use MGD	67,033,000	1,4424/	714	473	63	169	40,100,000	

Derived from waste load before treatment, adequacy of treatment and published data.

^{1/} Calculated waste load generated by entire 2 digit SIC group activity.

2/ Derived from waste load before treatment, adequacy of treatment and put

3/ SS - Suspended solids.

4/ Total includes undetailed breakdown of Planning Area No. 16 STG. Total includes undetailed breakdown of Planning Area No. 16 SIC groupings. Partial figures may not add to totals because of independent rounding off of numbers.

TABLE L-7(R) PRESENT AND FUTURE ORGANIC WASTE LOADS REGION SUMMARY

	Waste P.E.	Load ^a / (000)	Waste P.E.	Load ^{b/} (000)	Waste Load P.E. (000)			
<u>Year</u>	Before Treatment	After Treatment ^c	Before Treatment	After Treatment	Before Treatment	After Treatment		
1960	43,800 <u>d</u> /	16,300	67,100	40,000	111,000	56,800		
1980	55,700	8,360	144,000	21,600	200,000	29,900		
2000	69,800	7,820	303,000	31,900	373,000	39,800		
2020	86,600	9,760	624,000	65,800	710,000	75,600		

Industrial,

Total

Non-Industrial

Includes waste loads from municipalities, institutions and Federal installations.

Includes the waste loads from the six major water-using two digit SIC groups. This is considered to be a result of actual treatment practice carried out in

¹⁹⁶⁰ and then secondary treatment for 1980, 2000 and 2020.

Includes 5,956,000 persons not served by non-industrial waste collection systems.

E. MINE DRAINAGE

Acid Mine drainage and its effects on water bodies are currently of importance in the Lehigh and Schuylkill Basins in Subregion D and in the Susquehanna Basin tributaries in Subregion E. The State of Pennsylvania has initiated a program which should control the acid mine drainage in Pennsylvania.

F. THERMAL SOURCES

The most significant source of thermal discharges in the NAR are the nuclear and thermal electric power generating plants. The individual Subregion Chapters vary in the degree of identification of sources. It is expected that significant increases in thermal loadings will occur through the design period because of the anticipated rise in population and electrical power requirements. This pollution load will depend on the ability of the designers to tailor the new plants to meet established water quality criteria and standards.

Thermal pollution from manufacturing in Subregions C and D may well increase due to a projected rise in employment (and consequently, new plants) in the chemical and primary metals industries.

G. RECREATIONAL AND COMMERCIAL NAVIGATION

Over 700,000 small craft are registered in the NAR. Recreational boating constitutes a source of pollution because of the potential for the discharge of human fecal matter, litter, motor exhaust and oil. See the individual Subregional chapters for specifics.

The disposal of waste and the spillage of oil from commercial craft in the major ports of the NAR also contributes localized pollutional effects which will require specialized treatment.

The Water Quality Improvement Act of 1970, Section 13, deals with controlling the discharge of sewage from vessels into the navigable waters of the United States. Standards of performance of these devices are now being promulgated at the Federal level. Regulations are being developed governing the design, construction, installation, and operation of these devices. The standards and regulations become effective for new vessels within two years after they are established and for existing vessels within five years.

H. RURAL AND URBAN RUNOFF

Insufficient information is available to accurately portray the magnitude or types of waste loads that are being discharged to the surface waters of the NAR by rural and urban runoff. Rural waste loads include sediment, animal wastes, nutrients, pesticides, and infectious agents as well as those contained in urban runoff. An indication of magnitude and type of these loads is given in Section VI entitled "Agricultural Pollutants" in Chapter 1.

Urban runoff will become more significant in the NAR as more land is developed and is made impervious to precipitation. In addition to the quantities of urban runoff which affect the surface waters, the quality of the runoff is an item of growing concern. Urban runoff may contain oils, organic matter, trash, inert solids, salts, fertilizers and whatever else can be easily swept or washed into street gutters, storm sewer systems or the nearest water course. Those portions of the NAR which will undergo massive urban development through the target years will suffer from greatly increased loadings of urban runoff.

I. OCEAN DISPOSAL

The coastal waters of the NAR receive untreated or partially treated waste loads from municipalities and industries located along the coast (such information is covered under the Sections on Non-Industrial and Industrial Waste Loads). The waters offshore of Boston, New York, and Cape May have long been used as disposal sites for rocks, mud, dredging spoil, sewer sludge, and industrial wastes. Considerable study of the effects of disposal of these materials upon the ocean's biota is needed to determine the environmental impact. Over 15.4 million cubic yards of these materials were dumped in the New York Bight in 1966. The dumping of exotic materials off the Boston coast has temporarily been suspended since February 1970. Unless alternative methods of ultimate disposal are found, it is certain that the amount of wastes disposed of in the ocean will increase significantly through the design years.

J. CONSTRUCTION ACTIVITIES

The physical disturbance of the soil cover by construction activities for both buildings and roadways is and will continue to be of significance in the NAR. The sediment loadings to the streams become extremely significant in the estuaries and harbors: in the Susquehanna River alone, sediment discharge measurements indicate an annual load of three million tons of suspended sediment. For more detailed information see Appendix Q, "Sediment and Erosion", and Appendix H, "Minerals" of the NARS Report.

K. WATER QUALITY PROBLEM AREAS

Water must be kept as clean as possible and the quality of the water resource must be effectively protected and conserved. The excess of needs over available supplies can be met only if water reuse is made feasible. Pollution, which degrades water quality and impairs reuse, emerges as the most significant water problem.

Coupled with the Region's need for a quantity and quality of good water are the shifting goals of society. It is no longer sufficient to just supply water. It now must be supplied so that it will maintain a high quality environment as well as support an economic efficiency. This gives rise to conflicts in water use.

The Region's major problem of supplying an adequate quantity and quality of water to its burgeoning population is nowhere more acute than in Area 13 of Subregion C. Mounting water needs for all uses will exceed the total usable supply within the next two decades.

The water cycle can be pictured as a constantly turning wheel. Water falls on the earth, is used, is drawn back into the air and falls again. Nearly one-half of it is lost by evaporation and transpiration. A large portion of the remainder quickly floods back to the ocean preventing its use. Dependable fresh water supplies are not being developed at a rate commensurate with the growing municipal and industrial requirements. Therefore, multiple purpose surface sources must be developed for water supplies and should include provisions such as recreational activities as swimming, fishing and boating. At the same time a critical and increasing amount of the remaining water is being and will increasingly be spoiled by pollution unless steps are taken to eliminate it. Thus, the water cycle and consequently water use are being seriously interrupted by pollution. The result is a shortage of water.

Water shortages of extreme severity developed in the NAR during the recent five-year drought. The conflicts between users of water became more apparent than ever. Water for municipal and industrial water supply is secured from both surface and groundwater sources.

Conflicts also exist between power companies and fisheries. The power dam creates a block to natural fish migration.

The prevailing practice of weekend storage, which prevents flow in reaches immediately below hydroelectric plants, creates an unsatisfactory condition aesthetically, and adversely affects recreation and other uses downstream. Thermal discharges cause low dissolved oxygen levels and have detrimental effects on fish and other aquatic life. Other problems arise from the discharge of municipal and industrial wastes which render water for downstream users unsuitable and in need of treatment.

Problems created by conflicting uses of water have been increasing within the study area. Pollution problems will continue to increase in number, scope and complexity unless effective measures are taken.

The provision of municipal treatment facilities to service the increasing population is hampered by the existence of a substantial backlog of such facilities to care for present needs. Outmoded waste disposal practices, such as combined storm and sanitary sewer systems, further complicate the enormous task facing the Region's communities. Industrial processes are avid consumers and polluters of water supplies. Industry must assume its responsibility to adequately treat its expanding volume of wastes.

The above dissertation has shown the need for developing water resources. Water use problems and the water pollution crisis can be alleviated by solving the sum of the local problems. Treatment facilities can be built. Advanced technology and water use procedures have been developed and can be implemented, then further research and development to control the remaining problems will take on a new light.

It will take informed and dedicated citizens and officials at all levels of government to adequately mobilize effective programs to meet the challenge of solving conflicting water use problems. Although technology may be available, and water also available, people must be made aware of and given the incentive to carry out the corrective measures. Answers must be given as to who is to pay and who is to benefit.

An administrative apparatus which will enable authorities on all levels of government to work together and utilize available technology must be created and given the authority to implement its programs.

Refer to the individual Subregion Chapter, Sections VI: Present and Future Water Quality Problems for further detailed information.

L. POLLUTION CONTROL METHODS

In all Subregions of the NAR the most effective means of protecting the surface water quality is to prevent pollutants from entering the water. Portions of all major water bodies in the NAR are today seriously affected by pollution. It is only with significant waste removal from the discharges to the waters that we can hope to maintain the levels of water quality prescribed in the Water Quality Standards as indicative of the best usage of the water bodies.

In addition to source control of wastes, various study and management needs as well as research and development needs are required with specific needs designated in the Subregional Chapters, Sections VII.

M. PROGRESS IN POLLUTION CONTROL

1. INTERNATIONAL

The International Joint Commission (Canada-United States) has been active in the pollution control progress on the St. Croix River since 1962. Similar efforts by the IJC for other international water bodies would also be valuable.

2. INTERSTATE

Both regulatory and quasi-official interstate organizations abound in the NAR for the management, regulation as conservation of water resources. The most notable are listed below and their efforts are described further in Section VIII: Pollution Control Progress, of each Subregion Chapter:

New England Interstate Water Pollution Control Commission
New England River Basin Commission
Interstate Commission on the Champlain Basin
Hudson River Valley Commission
Interstate Sanitation Commission
Delaware River Basin Commission
Interstate Commission on the Potomac
Susquehanna River Basin Commission

3. STATE

Each of the States in the NAR has submitted and has Federal approval of a Water Quality Standards package for interstate (or international) waters. These packages include implementation schedules for achieving these standards. Refer to the Subregional Chapters for specific state activity.

4. FEDERAL

Federal involvement in efforts to eliminate pollution and enhance water quality in the Nation's waters was increased and broadened by the Water Quality Act of 1965, as amended. Federal participation in funding of new wastewater treatment facilities has been on a large scale in the NAR.

As a backup to State responsibility to water pollution control, the Federal government is authorized to hold enforcement conferences to ascertain the necessary abatement measures. A compliance schedule is made a part of such conferences.

The Federal Water Pollution Control Act was further amended by the Water Quality Improvement Act of 1970. Included as major items were sections to control oil pollution, hazardous polluting substances, and the discharge of sewage from vessels. Each of these sections has created intensified program efforts in each of the Water Programs Offices in the NAR Study Area. A Regional Contingency Team has been active in each Region to respond to oil or hazardous materials spills. Standards are now being developed for the effluent from marine sanitation devices.

In 1970, new regulations were developed under the "Refuse Act" of 1899 by the Corps of Engineers in conjunction with applications for permits authorizing discharges or deposits into navigable waters of the United States or into any tributary from which discharged or deposited matter shall float or be washed into a navigable water. The Environmental Protection Agency provides evaluation for the Corps of the effect of the discharges shown in the individual applications.

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY

APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 1 SECTION VI

AGRICULTURAL POLLUTANTS

Prepared by

ECONOMIC RESEARCH SERVICE, FOREST SERVICE AND SOIL CONSERVATION SERVICE U.S. DEPARTMENT OF AGRICULTURE

For the

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY COORDINATING COMMITTEE

May 1972

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INTRODUCTION

The preparation of the Water Quality and Pollution Appendix is the responsibility of the Environmental Protection Agency. Major inputs are provided by the Department of Agriculture and the U. S. Public Health Service of the Department of Health, Education and Welfare. This report describes agricultural pollution problems in upstream areas and suggests solutions for consideration. It serves as the Department of Agriculture's input into Appendix L. The material presented is limited to use of available studies and is shown by the six Subregions where sufficient data existed.

AGRICULTURAL POLLUTANTS

Kinds of agricultural pollutants in upstream areas of the NAR are sediment, animal and food processing wastes, plant nutrients, chemical exotics, and infectious agents. Agricultural pollutants are rarely discharged directly into the streams. They originate or are spread on the land surface. Transporters of these pollutants are water, wind, animals, and mechanical devices. Water is the most important; the pollutants are mainly carried to streams in runoff.

SEDIMENT

Sediment is considered to be the most important single pollutant of streams. Wolman and others emphasize that pollution of the Potomac River by sediment is so great it dwarfs the effect of all other pollutants. (1) It affects public health, municipal and industrial water supply, valley agriculture, drainage, irrigation, flood control, navigation, fish and wildlife, recreation, electric power production and road and highway maintenance.

Source. Sediment as used in this report refers to the soil separates, i.e., sand, silt, and clay. It has its source in erosion of one type or another. In the North Atlantic Region, sheet erosion on cultivated land and on land undergoing urban development is usually the source of the sediment that causes most downstream damage. In most forest and pasture land, gully type erosion generally produces the greater part of the sediment. Rill erosion on exposed soil, channel erosion in streams and rivers, and mechanical erosion on construction sites are other types of erosion. In small watersheds any one of the types mentioned above may be dominant. Estimates of sediment sources in 157 watersheds authorized for watershed protection measures

⁽¹⁾ Numerals in parentheses refer to the bibliography at the end of the Appendix.

under the Watershed Protection Act PL-83-566 indicated that 73 percent of their sediment yield was derived from sheet erosion; 10 percent from gully erosion; and 17 percent from other sources, such as, roadside erosion and sediment rates based upon present land use and treatment are shown in Table 1.

TABLE 1
EROSION AND SEDIMENTATION RATE

	: Soil,	: Sediment	:	Sediment
Subregion	: $Loss^{\perp}/$: Yield <u>2</u> /	:	Volume
	: Tons/S	q. mi./year	:	1000 Cu.yd./Subregion/year
A	170	13		458
В	437	32		1126
С	445	33		1052
D	1459	109		2287
E	1530	115		4891
${f F}$	1479	111		4202
REGION	917	69		14016

Source: Appendix Q, Erosion and Sedimentation

Most types of erosion have been greatly accelerated where man has indiscriminately cut forests, plowed grassland or misused land. Erosion on cultivated land is the source of much sediment. This erosion usually results from growing row crops on steep land, from straight row farming on slopes that should be contour farmed or terraced, and from too frequent cultivation of land that needs alternating row crops or grassland. Overgrazing leads to erosion on pastures and rangeland. Overcutting and grazing that destroys humus will result in erosion on farm woodlands.

Erosion of nonagricultural lands is the source of increasing amounts of sediment. Construction sites are highly susceptible to erosion. Large housing developments and major construction projects may keep an area bare and vulnerable for one to three years. (2) Erosion along secondary roads, highways and railroads is an important source of sediment. This erosion results from ditch scraping, improper sloping and lack of vegetation on cuts, fills and ditches. Industrial and mine wastes in some places are dumped into streams or left where they will be subject to erosion. These also contribute to the overall sedimentation problem.

^{1/} Soil Loss - gross amount removed from land.

^{2/} Sediment yield - net amount delivered to water bodies.

Of the 14 million cubic yards of sediment reaching the major rivers in the NAR, an estimated 56 percent comes from crop, pasture, and forest land and 44 percent from other and urban lands. The variance from one subregion to another can be seen in Table 2.

TABLE 2
SEDIMENT VOLUME BY SOURCE FOR GIVEN LAND TREATMENT LEVELS

	:	<u>1</u>	: <u>1966</u>		:	Land Treatment in 2020							
Subregion	:		:		:_	Present Level			:	Accelerated			
	:	Agr.	<u>:</u>	Nonagr.	<u>:</u>	Agr.	:	Nonagr.	:	Agr.	_:	Nonagr	
				Thousa	and	Cubic	Yard	s Per Yea	r				
A		340		118		297		193		293		188	
В		478		648		284		1709		281		1294	
С		432		620		282		1061		267		956	
D		1128		1159		444		2529		382		2033	
E		2869		2022		1608		4729		1348		3482	
F		2607		1595		1714		4048		1505		3200	
REGION		7854		6162		4629		14269		4076		11153	

Source: Appendix Q, Erosion and Sedimentation

Several examples provide further evidence that activities outside of agriculture are responsible for major sediment deliveries. The Potomac River, long known as a mud carrying stream, drains 11,580 square miles in Maryland, Pennsylvania, West Virginia, Virginia and the District of Columbia. Studies on the Potomac Basin as a whole indicate gross soil erosion of about 50 million tons a year. The sediment delivered to the Potomac estuary amounts to about 2-1/2 million tons a year. Suburban and industrial development is active on the outskirts of Washington, D.C. Utilities rights of way expose critical erosion areas that were formerly forested. Bulldozers frequently remove vegetation from hundreds of acres of land. The land is left idle for many months or even years until additional money becomes available for construction. The exposed subsoil in these suburban areas is extremely vulnerable by intensive rainstorms. Some estimates indicate that 25 percent of the sediment coming into the lower estuary of the Potomac now arises from suburban construction sites. (3)

Another example of accelerated erosion due to urbanization is shown in a study of a 14.3 square mile watershed above Lake Barcroft in Virginia, a suburban area of Washington, D.C. As the area of the watershed undergoing urban construction rose from less than .5 percent to nearly 9 percent annually, the volume of sediment reaching the lake increased from 4 to about 25 acre feet per year. The rate of erosion from urban construction is conservatively considered to be some three to six times the average rate for an agricultural area.

Sediment concentrations measured in runoff below a 150 acre industrial park under construction near Baltimore, Maryland were 20 times higher than in the area upstream from the industrial park. (4)

The extent and duration of bare soil exposure during residential, commercial and highway development are major factors in the accelerated rates of soil erosion. Development costs and time limitations cause contractors to clear large tracts of land rapidly. Certain grade relationships must be estimated between streets, sewers, driveways and highways. Severe erosion frequently occurs at the development site and damage may result where sediment is deposited in storm sewers, on streets, and in downstream channels and reservoirs. After construction including grading, seeding and paving is completed, erosion declines to a stable rate comparable with that from good pasture land. This nonfarm erosion will increase unless steps are taken to control it.

Effects. Loss of valuable storage in reservoirs is a major consequence of sedimentation. Reservoir sedimentation surveys made on 36 reservoirs in the NAR show an average annual rate of storage loss due to sediment to be 0.17 percent. The rate of storage loss varies a great deal among ponds and reservoirs; annual storage losses for the reservoirs surveyed in the NAR vary from .01 to 6.09 percent. Generally, small ponds and reservoirs are filled more rapidly than larger reservoirs. The length of time it takes a pond or reservoir to fill with sediment is not an accurate means of measuring the damaging effects of sedimentation; many will become nuisances and/or useless long before their storage capacity has been completely replaced by sediment.

Sediment deposited in navigable channels, harbors and estuaries must be removed regularly in order to maintain necessary depths for shipping. In the Delaware River below Trenton, the Corps of Engineers and private industry spend nearly \$10 million a year for dredging. (6) Maintenance costs for sediment removal from the Hudson River channels and pier slips are in excess of \$3 million annually. Local interests state that the heavy rate of siltation in the pier slips, requiring frequent and costly dredging, is one of the major reasons for the reduction of commercial activity on this waterway. (7)

Sediment fills highway and roadside ditches, plugs culverts and bridges, and clogs constructed channels and ditches for drainage systems. Damage to transportation facilities results in higher taxes and fares to pay for repairing the damage. Agricultural production costs and consequently food prices are higher. Wet basements and damp walls lower property values. Vector problems increase health hazards. Costly maintenance operations are necessary to insure that channels remain effective.

Most sediment caused by a particular erosion event is deposited

in small or headwater tributaries. Deposition may occur at changes in upland slope, on flood plains, or in stream channels. Sediment accumulation in stream channels reduces the capacity of channels to handle large discharges. This results in more frequent flooding. The cost of cleaning up sediment deposited in streets, houses, machinery, automobiles, sewer lines, wells, etc., after a major flood is tremendous. For example, it cost \$3.87 million to remove the sediment from the streets and cellars of Johnstown, Pennsylvania after the March 17, 1936 flood. (2)

Water for approximately 80 percent of the population of the NAR served by municipal water facilities is supplied from surface sources. (8) Most of the facilities distributing surface waters apply some sort of treatment to the water. Filtration for removal of sediment and other solids is almost a universal practice where surface waters are used in municipal systems. Removal of sediment is only one of several processes in most water treatment plants; however, it does add substantially to the cost of operations. Studies have shown that a 30 percent reduction in suspended matter in streams could result in a treatment cost saving of 10 percent. (9) These savings are due primarily to a reduction in the requirements for alum for floculation, and less frequent cleaning and disposition for silt from settling basins.

Sediment reduces the attraction of many water bodies for swimming and boating. Water is roiled 3 to 10 days following periods of runoff. Swimming visitor days drop substantially while water is roiled. Chemical waters carried by sediment may cause the beach waters to be unsafe. Turbid water discourages boatsmen.

Sediment ruins fisheries. It covers the bottom of streams and bays and destroys the spawning beds of game fish and seed beds of shell fish. It reduces their food supply. Fish eat worms, insect larvae and other small aquatic animals that feed on microscopic plants. In many small streams, sediment fills the deep pools that provide a refuge for fish during the dry season. Most streams and lakes no longer have as many game fish as they once had. Coarse fish such as carp and suckers that thrive in muddy waters are replacing the game fish. Similarly, sediment is a major factor in causing oysters to disappear from the Chesapeake and Delaware Bays.

Effects of sedimentation are customarily thought of in engineering terms, such as rates of reservoir silting, dredging of harbors or the effects of sediment in water on morphology and stability of stream channels. Now other possible influences of sediment on the environment are beginning to be recognized. There is concern, for example, about the role of sediment as a carrier of pesticide residues, agricultural wastes, and plant nutrients, especially phosphorous and nitrogen.

Controls. Land use and development involve varying degrees of

soil disturbance which results in erosion on croplands and grasslands, on some forest lands and on lands occupied by urban and related developments. These disturbances have accelerated erosion much beyond natural rates. These excessive rates and the resulting sediment can be avoided or greatly reduced. Soil conserving cultivation practices, efficient use of irrigation, timber harvest adapted to the soil, careful road location and construction all will reduce erosion and sedimentation hazards. (10)

Watershed protection, one form of pollution prevention, helps keep both soil and runoff on the land. Long experience has shown that conservation measures markedly reduce sediment loads. Contour farming reduces soil loss 50 percent and terracing 85 percent as compared to straight row farming. Other farming practices that greatly reduce soil loss include contour stripcropping and a conservation cropping system, controlled grazing, and fire prevention measures for forest land. Returning steep cultivated land to woods or pasture is necessary in some places. Some gullies can be sloped in and seeded with grass or trees. Others may need small drop structures. Raw.streambanks can be protected by riprap, jetty construction, planting of willows and other methods. Flood plains subject to scouring by floodwater can be protected by grass or brush. In areas where agricultural land is being converted to urban development, vegetation of any kind should be left until just before construction begins. Only the minimum area required for operations should be disturbed at one time. Exposed soil needs to be covered as soon as possible. When extended periods of exposure are unavoidable, temporary cover should be provided. Annual grasses, small grains or sod make a quick cover. Mulch, burlap and plastic also protect the soil. Contour diversions can be used to intercept runoff and channel it to waterways that lead it by means of meanders or drop structures to safe outlets. Sediment traps and debris basins hold sediment on the construction site.

Minimum acreages on which erosion control measures should be applied are shown in Table 3. The sediment reductions resulting from land treatment are the differences of the last two sets of colums of Table 2. Explanations and further breakdowns are in Appendix G, "Land Use and Management", and in Appendix Q, "Erosion and Sedimentation".

TABLE 3

LAND REQUIRING EROSION CONTROL MEASURES (Suggested Treatment through 2020)

Subregion :	Agricultural ¹	: Nonagricultural	:	Total
	(100	00 acres)	-	
Α	380	60		440
В	560	450		1010
С	860	250		1110
D	940	830		1770
E	3690	920		4610
F	6120	1170		7290
REGION	12550	3680		16230

Landowners and operators help prevent erosion and sediment damages by preparing basic plans to determine needed action for the conservation and development of soil and water resources of their land and by applying land treatment called for in their conservation plan. Communities, town, townships, cities and counties can help prevent erosion and sediment demage by planning the development of their land and water resources, and making plans binding through zoning regulations. Many communities require that builders and planners adhere to specific regulations in clearing an area for building. Some require that urban planning be based on a scientific soil survey. land use plans can and need to suggest how private and public improvements and land uses can be carried out in the best interest of all the people. Many railroad and highway departments are finding it pays to plan road cuts and fills so that erosion will be minimal. Costs of planning and applying measures for protecting watersheds are shown in Table 4.

^{1/} Includes retreatment acreage.

TABLE 4

COST OF WATERSHED PROTECTION

:	Land	Treatment	Mea	asures	:		:	Total
Subregion:		on Control	-	Other	•	Technical	:	Watershed
:	Agric.	: Nonagric.	:	Measures	:	Assistance	:	Protection
		(N	lil.	lion Dolla	ır	s)		
Α	7	2		39		13		61
В	15	28		163		61		267
С	45	12		91.		33		181
D	23	42		115		35		215
E	128	80		70		49		327
F	117	85		84		59		345
REGION	335	249		562		250		1396

Source: Appendix G, "Land Use and Management", Table G-68.

Grass, brush, and trees next to the streams, rivers, and lakes catch sediment. These buffer strips filter runoff water. Vegetated banks help prevent channel erosion. The vegetated areas can also serve as wildlife habitat, recreational areas, and visual open spece.

Special structural measures are sometimes needed. Weir notch or box inlet drop spillways, retaining walls, gabions, riprap, and jetties are used to stabilize grade, control head cutting in channels, prevent sloughing, and deflect channel flows.

Watershed protection is to minimize sediment at its source. The values shown in Table 4 do not reflect special protection emphasis to areas immediately adjacent to bodies of water. In addition to usual watershed protection measures, grass filter areas surrounding water bodies, and specially designed and constructed structures are needed to control erosion and ensuing sediment.

ANIMAL WASTES

At one time animal wastes were considered an asset in providing fertility to the soil. Times have changed. More recently animal wastes are considered by many to be the most fearsome agricultural waste. The changes in view toward manure have occurred because livestock and poultry production is becoming concentrated in large scale, confinement-type enterprises. Such concentrations have greatly magnified the problems of handling wastes, health hazards, and aesthetic nuisances.

Source. Animal wastes lower quality of water through their high biochemical oxygen demand (BOD) and through the addition of nutrients.

BOD is used as an indicator of pollutional strength. Most farm animals daily produce fecal matter having greater BOD than that of man. Total solids produced is also more than that of man. See Table 5.

TABLE 5
LIVESTOCK POPULATION AND WASTE

	Livesto	ock Popu.	lation		:	Animal Waste			
:	Catle	: Hogs	: Sheep	: Chickens	:	Population	n E	quivalent	
Subregion			and	: and	:		-:-	Total	
and Area :	Calves	: Pigs	: Lambs	: Turkeys	:	BOD	:	Solids	
		1000	Animals	3		1000	Hu	mans	
A	136	8	21	4062		2348		4432	
В	459	123	27	10730		7969		14751	
С	982	34	26	4303		16289		28243	
D	541	217	33	15360		9573		17981	
E	1464	368	92	14760		25149		44323	
F	1182	358	215	13747		20778		36481	
TOTAL	4764	1108	414	62962		82106		146211	

Wastes generated by livestock on pasture and in fields do not contribute significantly to the problem. Large animal or bird numbers confined to small areas, particularly areas along streams, are the main source of animal wastes entering the stream.

A review of census data shows a strong trend toward increased concentrations of livestock units. The decrease of number of farms in the NAR has been accompanied by an increase in numbers of livestock per farm.

TABLE 6

LIVESTOCK NUMBERS AND ENTERPRISES IN THE NAR

	: Cattle &	: Hogs & :	Sheep &	:
	: Calves	: Pigs :	Lamb	: Chickens
		(Units in th	nousands)	
Units of Livestock	k			
1950	4782	1649	442	47831
1954	5387	1585	633	59399
1959	4907	1565	618	52802
1964	4764	1108	414	51448
Farm Enterprises	(number in thous	ands)		
1950	363	164	42	295
1954	267	144	57	234
1959	190	100	61	140
1964	149	54	38	73
Livestock per Far	m Enterprise (ur	its per farm)		
1950	13	10	10	162
1954	20	11	. 11	254
1959	26	16	10	377
1964	32	20	11	705

Removal from animal lodgings, transport and, where feasible, spreading of animal wastes on land represent a significant item in the cost of production. A 1961 Michigan study indicated that beef feedlot operators spend \$3.43 per head marketed, and dairymen \$9.29 per head for waste removal and spreading. A Maryland egg farm, with automated cage operations, spends a half cent per dozen of eggs. Other operators of egg farms have reported costs more than double this amount. Eastern shore broiler producers are paying one cent a bird to contract removal companies for each cleaning which may be as frequent as four times a year. Mineral nutrients cannot economically be returned to the soil from where they came.

Agricultural methods are changing with time. The changing values of our society also create demands for change in agricultural methods. Urbanites, suburbanites, and rural nonfarm dwellers refuse to tolerate obnoxious odors or unsightliness generated from livestock operations. Formerly acceptable practices cause nuisances offensive to today's populace.

Effects. Runoff carrying barnyard and feedlot wastes have a BOD varying from 100 to 1500 ppm depending on dilution and degree of deterioration of wastes. Water using 5 ppm or more of oxygen is of doubtful purity. (3)

The Interstate Commission on the Potomac River Basin reported in 1969: "Every time it rains, enormous amounts of animal wastes are washed from farmyards into the river rendering it unsafe for swimming." Fish kills below cattle feedlots are reportedly due to a lack of dissolved oxygen and/or ammonia nitrogen concentrations. (11) There is too little oxygen available in some low stream flows to satisfy needs of fish life and oxidation of organic pollutants.

Controls. Animal wastes management must not be considered as a separate problem. The producer and the consumer need to realize cost of animal waste disposal is part of the price to be paid for a high standard of living. (12) Research is needed to develop disposal and utilization systems consistent with the public demand for quality water at an affordable price.

Costs of waste treatment and disposal cannot be recaptured with present technology and institutional arrangements. Fecal material is an energy source presently discarded. Animal (and human) wastes are productive land additives currently compounding disposal problems. Discovering how to use this potential energy source and how to recycle potential plant nutrients can change these waste materials to social benefits.

Practices found helpful in reducing stream pollution potential from feedlots are: (a) detention ponds to spread runoff 24 hours or longer. This technique not only prevents some of the slugging nature of the material, but also discharges wastes at a rate more easily treated; (b) diverting all rainfall not falling directly on the feedlot surface around the entire facility; (c) maintaining lots so that their litter remains as dry as possible, that is, designing for good drainage, preventing water-logged areas and preventing overflow from watering devices (13); (d) deep manure stabilization ponds for anaerobic decomposition; aerobic sewage lagoons; (e) oxidation ditches using mechanical aerating systems (14); (f) divert runoff flows onto wooded or grass areas having high infiltration capacities (3); and (g) establishing vegetated buffer strips adjacent to feedlots and/or streams to intercept runoff and act as natural filterbeds.

PROCESSING INDUSTRIES WASTES

Oxygen demanding wastes from processing agricultural and forestry products include runoff or effluent from woodpulp, paper and fiberboard manufacturing; fruit and vegetable canning, cleaning dairy plant tanks and other equipment; slaughtering and processing of meat animals, tanning; manufacturing cornstarch and soy protein; sugar refining; malting, fermenting and distilling; scouring wool and wet processing in textile mills.

Source. The woodpulp, paper and fiberboard industry is large and the location and size of individual plants make their contribution

to stream pollution especially noticeable. The processing of wood to pulp produces approximately 1,000 pounds of dissolved organic matter per ton of pulp. The wastes contain large amounts of lignin and about 20 percent fermentable sugars. Since lignin and cellulose oxidize relatively slowly, the BOD values given for pulp and paper manufacturing are low in relation to the total organic pollution from these industries. See Appendix L for this industrial contribution to the total waste load.

Processing farm products for food is a principal agricultural processing industry. Canning wastes consist of wash water from the raw fruits and vegetables, from the cutting and peeling rooms, and the cooking sections. These wastes contain relatively large amounts of solids most of which can be filtered out or precipitated chemically. Frozen fruit and vegetable packing probably has wastes comparable to canning on a per pound basis, since the major sources of wastes are similar.

The dairy industry is one of the major food industries. Milk, cheese, butter, dry skim milk and other important food products, such as evaporated milk, add considerable to the industries' waste disposal problems. Receiving and bottling operations in handling whole milk may accumulate potential wastes equal to the daily wastes of 1.4 million people in the North Atlantic Region. Whey from the manufacture of cheddar cheese is a major byproduct and waste disposal problem. About 17 percent of it is processed directly into whey powder. Small amounts of the remaining whey are converted into lactose, albumin and other whey products. Cheese plants situated in areas of high hog production sell, give away or pay farmers to take whey. More than half of these plants reported that they dispose of all or part of their whey as waste or sewage. (8)

The meat processing industry is a potential source of tremendous BOD loadings. Wastes originate in the slaughtering of animals for food and in the preparation of animal products for market. Stockyard wastes contain animal excreta. Slaughter house wastes contain blood, paunch manure, flesh, grease, hair and dirt. The pollutional load contributed by the meat industry is equal to that of approximately 2.5 million persons.

Tanning is the oldest agricultural industry probably predating the milling of grains. (8) Tannery wastes contain large amounts of suspended matter including dirt, manure, blood, fat, lime, hair and particles of flesh. There are some minor losses of organic wastes in the finishing and dyeing of leather.

<u>Effects</u>. The estimated total pollutional load from selected industries is shown in Table 7. The figures are based on a similar table prepared for the United States by Hoover and Jasewitz. (15) The data are based on information obtained from articles in the sanitary engineering journals, from the U.S. Public Health Services'

Industrial Waste Guide, and from text books. Estimates have been made where recent information is not available. Table 7 is an attempt to estimate the proportion of potential daily load (BOD) that is in the NAR from the national table. The last column expresses the potential pollutional loading in population equivalents. The common value of 0.167 pounds of BOD per capita per day is used.

TABLE 7

ESTIMATED POLLUTION LOADINGS OF SELECTED AGRICULTURAL PROCESSING INDUSTRIES FOR THE NAR WATER RESOURCES STUDY

· · · · · · · · · · · · · · · · · · ·	** G /15\		 		37.470 10	
	U.S. (15)	:	D	:	NAR Pot	
Processing :	Potential	:	Estimated	:	Daily	
Industry :	Daily Load	:	percent	:		1000 human
<u></u>	(5 Day BOD)	:	in NAR	:	5 Day BOD:	pop.equiv.
	1000 lbs.				1000 lbs.	
Canneries			10.00		01.0	0.5/0
Apples	44.0		48.00		21.2	3,540
Peaches	169.0		0.66		1.1	184
Corn	63.0		15.00		9.4	1,570
Tomatoes	113.0		13,00		15.0	2,505
Corn						
(Wet Milling)	133.0		2.40		3.2	534
n .						
Dairy	160.0		05.00		/ O F	6 761
Fluid Milk	162.0		25.00		40.5	6,764
Evaporated Milk	11.6		14.50		1.7	284
Nonfat Dry Milk	157.0		15.00		23.6	3,941
Total Cheese	1,652.0		10.00		165.2	27,588
Meat						
Hides & Leather	300.0		7.00		21.0	3,507
Slaughtering &	300.0		7.00		21.0	3,307
Packing	2,300.0		18.00		414.0	69,138
Tucking	2,500.0		10.00		12140	07,130
Poultry	225.0		20.00		45.0	7,515
Soap	3,700.0		3.00		111.0	18,537
Wool Scouring	100.0		13.00		13.0	2,171
Paper & Pulp						,
Wood Pulp	27,000.0		20.00		5,400.0	901,800
Paper & Paper	, , 0				, ,	,
Board	9,000.0		28.00		2,560.0	427,520
Potato Processing	347.0		32.00		111.0	18,537
10tato 1100cooing	3.,.0		32.00		11110	10,557

<u>Controls</u>. Many of the practices found helpful in reducing stream pollution potential from feedlots can be modified to be helpful in reducing pollution potential from processing industries. These

modifications are necessary because of (1) plant operations resulting in large waste concentrations, (2) high seasonal loadings, and (3) different types of loadings.

Some wastes from agricultural and forestry processing industries are difficult to treat by conventional methods. Feathers, grease, hair and milk wastes clog filters in municipal waste treatment plants. Treatment is inadequate or the whole load is by passed. Consequently, contamination potential exists even where sewage treatment facilities have been established.

Solids dumped on the land need to be incorporated into the soil. Liquid wastes sprayed on the land need to be limited according to soil premabilities. Possibilities of waste water utilization for crop production and turf management need further exploration. Possibilities of using holding ponds to grow fish, plant, and fungicultures for protein sources need research. New processing techniques need to be developed to reduce pollution potential.

PLANT NUTRIENTS

Fertilizers have made it possible to produce more crops on less acreage. Fertilizers are an integral part of intensified agriculture; they must also be regared as a potential source of water pollution. Plant nutrients removed on sediment, in runoff water, and by leaching may produce two pollution problems: (a) accelerated eutrophication of surface waters, and (b) ground water contamination.

<u>Source</u>. Nitrogen, phosphate, and potash are the major plant nutrients in commercial fertilizers applied on agricultural lands. Animals and human excretions contain these nutrients. Naturally fertile soils contain substantial amounts of calcium and phosphorus.

TABLE 8

PLANT NUTRIENT QUANTITIES IN THE NAR 1964

	: A	nimal W	astes	:		Comme	er	cial Fertilize	r	
Subregion	:	Nutrien	ts	:	Nutri	ents	:	Area	:	
	: N	: P ₂ 0 ₅	: K ₂ 0	: N	: P ₂ 0	: K ₂ 0	-:	Applied	:	Cost
	:	(1000 t	ons)	:	(1000	tons)	:	(1000 acres)	:	(\$1000)
	1.0	_	0	-				0.4.0		0151
A	13		8	1	6 20	20		248		9151
В	42	18	28	2	3 26	5 23		499		11550
C	69	24	50	1	8 24	22		782		13920
D	54	22	34	4	5 54	¥ 51		1274		24304
\mathbf{E}	115	44	83	6	6 84	¥ 81		2677		40753
F	97	37	70	4	2 57	7 58		1667		24472
REGION	390	151	273	21	0 265	255		7147		124150

Phosphorus is getting into streams from farmland; however, it mainly gets into surface water through erosion of topsoil. Water seeping down through the subsoil, or moving laterally through the soil, carries virtually no phosphorus because of the high capacity of soil particles to absorb phosphate. Soil particles have a tremendous affinity for holding onto phosphate molecules. Topsoil contains on the average about 2000 p.p.m. of phosphorus adsorbed on soil particles. Even when the fine suspended particles in a river water contain 1,000 p.p.m. of phosphorus adsorbed on their surfaces, the phosphorus in true solution may be only 0.005 to 0.010 p.p.m. Water samples, therefore, should be analyzed in a way that distinguishes between phosphorus in true solution and phosphorus adsorbed on suspended sediment.

Barnyard waste carries around 1,000 p.p.m. of phosphorus. Runoff that flows directly from feedlots and barnyards into stream channels may be an untold source of phosphorus. (1)

Domestic sewage, which contains large amounts of washing detergents, is a major source of phosphorus in our surface waters. Detergents used in households and industry provide an abundance of soluble phosphate to sewage effluent. Evidence indicates that sewage delivery of phosphate amounts to 2 pounds per person per year. If the sewage effluent from 1 million people enters a stream with an average annual flow of 5,000 cubic feet per second, the average phosphorus content will be 0.2 ppm. This level is more than ample to enable excellent growth of algae without the phosphorus from other sources.

Losses of nitrates by leaching and runoff are probably greater than losses by any other nutrient. (16) The sources of nitrate and nitrite in ground water are usually considered to be: (a) naturally occurring accumulations, (b) nitrogen fertilization, (c) sewage, (d) industry and (e) barnyards. Conclusive evidence is lacking that chemical fertilization of fields result in high nitrate levels in well water. Natural nitrification processes in soils and nitrification of sewage effluent and animal wastes do seem to be major contributors when nitrate is found in ground water. The general problem is one of growing importance and much more definitive information is needed. (1)

Effects. Many of our rivers, estuaries, ponds, lakes and reservoirs are being ruined by a tremendous growth of algae, referred to as "algal blooms", and other aquatic plants. These blooms are not pretty, and when they die and deteriorate they emit very unpleasant odors. The decaying plant life also robs the water of the dissolved oxygen that may have been present. The water becomes uninhabitable for fish and unsuitable for recreation. These excessive growths of water plants constitute the accelerated eutrophication of surface waters. The natural process is speeded by the addition of mineral nutrients. In most waters, the main limiting factor for algal growth

is phosphorus, since other elements, such as nitrogen, potassium, calcium and magnesium are present in much more abundant supply.

Concern is mounting over the presence of nitrate and small amounts of nitrite in ground water in many parts of the country because of the toxic effects of livestock and rural people using wells for drinking water. Nitrate poisoning can affect both cattle and infants. There are no reports of methemoglobinemia in infants (blue baby) fed water from public water supplies in the United States, although nitrate levels in some may be in excess of 45 mg/l. $^{(17)}$ Rural people must be concerned with the nitrate content of the water in their water supplies. Smith $^{(18)}$ found that animal wastes, improperly constructed shallow wells, and septic tank drainage were the main sources of water contamination.

Controls. It must be concluded that the best way to control the phosphorous burden in streams, ponds and reservoirs that arises from agricultural sources is to use soil conservation practices, and structures that reduce runoff and sediment delivery from fields and farmsteads.

Properly designed and constructed septic systems and wells, protection of surface supplies from contaminates, and proper disposal of animal wastes would aid in keeping self supplied water systems low in nitrates. Public water distribution systems and public sewage systems are needed to serve more densely populated rural areas.

CHEMICAL EXOTICS

The potential contamination of the environment by detergents and pesticides has properly concerned the public. The Senate Select Committee on Water Resources states that organic chemical pollutants constitute "a water problem of great concern which will increase manifold in significance in the future."(3)

Source and Effects.

Detergents in surface waters do not pose an apparent hazard to humans or animals. Detergents carry phosphate as an active component. When sewage effluents enter rivers, lakes and estuaries, the phosphate becomes a key plant nutrient, promoting the development of obnoxious algal blooms. The role of phosphate is discussed in the section on plant nutrients.

Detergents entering into sewage effluent from rural homes, rural communities, or camping areas adversely affect the operation of septic tanks. These chemicals effectively disperse the soil particles as part of their cleansing action. They retain this capacity in moving through a sewage disposal system dispersing the effluent. Clay particles adjacent to the tiles become dispersed, and seriously lower

soil permeability to water near the tile line. Septic sewage disposal systems have become inoperative or malfunctioning, depending on the nature of the soil. Adverse effects of detergents on the tile dispensing system may be especially serious in soil containing appreciable amounts of clay.

If treated sewage effluent is used for irrigation, and if detergents in the sewage are not biodegradable, use of such water could impair rate of infiltration of water into the soil and possibly lower irrigation efficiency. This possible adverse effect on detergents on agriculture has not been fully explored.

Pesticides

The use of chemical pesticides has done a great deal of good. They have helped to produce, protect, and improve the quality of our food, to suppress pests that transmit disease, to eliminate poisonous plants on wildlife grazing areas, and to reduce weed growth in water permitting growth of food plants needed by fish. Plant diseases, insects, weeds, and animals harmful to man, livestock, farm crops, forests and wildlife have been reduced by the use of pesticides.

Nevertheless, chemical pesticides are poisons. They are dangerous if carelessly or improperly used. In some instances, what was thought to be proper and cautious use of a pesticide has resulted in the death of beneficial insects, fish and birds. Some pesticides leave a lasting residue which may move in water, air, and food into the bodies of animals, including man. This is of serious concern to scientists and all concerned with human welfare. (19)

Herbicides for aquatic weed control are subject to regulation and restrictions. No organic herbicides are registered for use in water that is to be used for irrigation purposes.

Many aquatic herbicides, such as diquat, potassium and sodium salts of endothall, sodium arsenite, silvex, 2,4-d, and dichlobenil, do not injure fish at the concentrations required to control most submersed aquatic weeds. At higher rates, they may become toxic to fish, humans, livestock, wildlife and crops. Dalapon does not harm fish, even at concentration levels far above those required for aquatic weed control. Copper sulfate usually does not injure bass, bluegill and certain other fish, but kills trout at concentrations necessary to control algae. Copper sulfate is considered safe in drinking water at concentrations up to 3 p.p.m.

Acrolein, chlorinated benzenes, xylene and amine salts of endothall are deadly or injurious of fish at concentrations necessary to control aquatic weeds, and are not registered or recommended for use in areas where protection of fish is required.

Sodium arsentite at rates required to control many aquatic weeds

is not toxic to fish. Sodium arsentite is highly poisonous to humans and all warm-blooded animals, and extreme caution and attention to details of application are absolutely essential when it is used. It has been used extensively since 1930 under rigid State and local regulations, with few human fatalities or injuries or serious losses of livestock or wildlife. However, its use is now being generally discouraged in many localities and states.

Harry W. Hayes of the USDA Pesticides Regulation Division recently said "To secure registration of a pesticide for use in water, the registrant must submit a label in proper form along with data that is adequate to support the claims made for it. The data must show that the pesticide when used as directed is effective and safe on exposure of humans, domestic animals, fish, wildlife and desirable vegetation, and it will result in no illegal residues in or on the raw agricultural commodities involved. Fish are classed as raw agricultural commodities." Out of the array of herbicides with aquatic use labels and USDA registration numbers, only copper sulfate has unrestricted use in fisheries.

<u>Insecticides</u>, especially the chlorinated hydro-carbons, are a matter of public and private discussions. With a few years after DDT began to be used extensively as a field and forest insecticide, DDT and its metabolites were found in the fatty tissues of fish and wildlife. Newspapers carried features on fish and wildlife losses, with an implicit indictment of agriculture and forestry for having used insecticides.

Many of the new synthetic organic insecticides are extremely toxic to fish. Endrin, Dieldrin, Toxaphene, Guthion and DDT are acutely toxic to fish at very low concentrations. Runoff from areas treated with these materials has been toxic to fishes in several instances.

Shellfish samples from eight states in various parts of the country contained DDT and DDE residues, ranging from less than 0.008 p.p.m. to 0.9 p.p.m. $^{(20)}$ Some conservationists believe that certain marine fisheries' resources, such as shrimp, salmon and oysters, may be adversely affected in river estuaries. Many of these materials have a long residual toxicity in the soil. Some of these residuals have demonstrated that as the period of exposure is increased, concentrations which are toxic become correspondingly smaller.

Other pesticides include nonaquatic herbicides and growth regulators, acaricides, fumigants, nematocides, and rodenticides.

Controls.

<u>Detergents</u> that do not cause algae growth and will decompose in sewage treatment processes need to be developed for use. Percentages of phosphates in major detergents range from less than two to over

forty percent. Substitutes for detergent phosphates are available. Product standards need to be established.

Pesticide chemicals must be approved by the U.S. Department of Agriculture, Department of Health, Education and Welfare, and the Department of the Interior before they are offered for sale. The label, as well as the chemical, must be approved.

All legal labels must include:

- a. Name of the manufacturer.
- b. Name of the product.
- c. Active chemical ingredients and percentages.
- d. The type of chemical (herbicide, insecticide, etc.)
- e. Recommendations for specific uses.
- f. Directions for use.
- g. Storage precautions.
- h. Personal precautions.

Continuted testing, evaluation, and re-evaluation for regulation and restriction will provide safeguards against irreparable damage to water supplies from pesticides.

A chemical pesticide must be used with care. Its use requires:

- a. Careful application as to amounts and area in accordance with limitations stated on the label.
- b. Protection of application operators.
- c. Neutralization, deactivation, and cleanup of spills.
- d. Care in cleaning application equipment.
- e. Adequate safe disposal of containers.
- f. Safe storage and transport to avoid accidents.

Substitutes that are more selective and less toxic, hazardous, and persistent are being used. For example, because of its potential effect on fish and wildlife, the U.S. Forest Service is restricting the use of DDT for the control of spruce budworm, pine tip moth, tussock moth, and other destructive forest pests. Substitute materials are used wherever possible. A wider choice of substitute acceptable chemical pesticides needs to be developed.

Other methods of control need to be explored. House screens, rat traps, and fly swatters are examples of mechanical methods. Physical methods involve the use of electric shocks, sound waves, light, and extremes in temperature and humidity. Use of cultural methods as crop rotation, pruning, planting dates, development of resistant strains, and growing healthy plants and animals is probably the oldest of the control methods. Biological control appears to hold promise for future years; in fact, this method involves (1) favoring naturally occurring predators, parasites, and disease organisms, (2) rearing and releasing them in the field at critical

times, or (3) introducing new ones from other areas. (21)

INFECTIOUS AGENTS

Bacteria, fungi and viruses are infectious agents that cause disease in or on plants, animals and humans. The infectious agents are transmitted or dispersed by nearly every segment of the plant and animal kingdom. When transmittal of the agent is uncontrolled, serious outbreaks of diseases occur. Control measures are constantly being researched. The tested results of research are providing more effective control against infectious agents.

Source. In upstream watersheds the infectious agents can be found in sewage, animal wastes, landfill seepage, and in wet breeding areas for flies and mosquitoes. The infectious agents of concern in this report are related to water.

Effects. Fecal matter found in farm ponds, lakes and streams, often journeys downstream where once children used to swim in unpolluted waters. The water receiving animal and human wastes will have fecal coliform and fecal streptococci bacteria present. These bacteria have been used for about 75 years as indicators that infectious organisms may be present. The source of the bacteria present is based on the ratio of fecal coliform to fecal streptococci.

Average contents of f. coliform and f. streptococci in fecal wastes of various animals, and ratio of f. coliform to f. streptococci (1)

Vertebrate	f.coliform	f.streptococci	: f.coliform-f.streptococci : ratio
	Millions	Millions	
Cow	0.23	1.3	0.18
Pig	3.3	84.0	.04
Sheep	16.0	38.0	.43
Poultry	1.3	3.4	.38
Turkey	.29	2.8	.10
Duck	33.0	54.0	.61
Man	13.0	3.0	4.33

Fry's report indicates that the lower Potomac River may never again be safe for swimming because of pathogenic bacteria. (1) He found the ratio of fecal coliform to fecal streptococci to be as follows:

Shepherdstown, W. Va.	0.07
Charles Town, W. Val.	0.24
Point of Rocks, Md.	0.25
Frederick, Md.	4.36
Great Falls, Washington, D.C.	0.04

The results indicate that the major pollutant at Frederick, Md. is from human sources. Fry concluded that most of the bacterial pollution was from animals and land runoff. Other sources indicate that there is no justification for distinguishing between human and other warm-blooded animal sources of coliform organisms. There is ample evidence in the scientific literature that animals, both wild and domestic, are a major reservoir of organisms pathogenic to humans. The f. coliform group, as inhabitants of the intestines of animals, is an indicator of fecal pollution. Fecal coliform criteria are currently under development. (22) The presence of these bacteria indicates a potentially hazardous condition.

Polluted streams may carry bacteria, fungi and viruses that will cause human diseases (23) such as: Leptospirosis; circling disease, swine erysipelas; tularemia; undulant fever; food poisoning; gastroenteritis; tetanus, lockjaw; St. Louis encephalitis; hepatitis; Aspergillosis; and Sarcosporidiosis.

A disease of growing concern is food poisoning caused by Salmonella paratyphoid. It is found in septic fields and is in sanitary landfill seepage. Improperly designed sewage disposal areas can lead to pollution of our water supplies. In Virginia, 64 cases of gastro-intestinal illness occurred in April 1967. Well water was polluted by drainage from a septic tank and a stream fed by a contaminated lake. (24) Another important disease is tularemia. During the 1968 outbreak in Vermont, 46 cases of tularemia were reported by trappers and handlers of muskrats. Contamination of the water presumptively occurred by decomposition of diseased wildlife. (25)

Vectors are insects such as mosquitoes or other arthropods that directly or indirectly transmit a disease agent or cause annoyance or irritation to man. Mosquitoes breed profusely in polluted water areas having either or both organic sewage and inorganic materials. Some of the more important Vecotor-borne diseases include Eastern, Western, and St. Louis viral encephalitis, malaria, and Rocky Mountain spotted fever. Of the diseases, viral encephalitis (sleeping sickness) is potentially the most important. This viral disease has caused sickness in man, animals, birds and amphibians. It can cause permanent brain damage and often death. In 1968 there were six deaths from twelve reported causes in New Jersey. In 1964 in the Philadelphia area 117 cases resulted in eleven deaths. A chief factor in the 1964 epidemic was the excessive buildup of the northern house mosquito due to sewage pollution in several creeks and steams in the area. See Appendix V, Health Aspects - Vector Control, 1969.

Control. Control of an infectious agent depends on a knowledge of the ways the agent is transmitted and the situation it must have to attack and grow on or in a plant or animal. When adequately controlled, an infectious agent is prevent from causing serious outbreaks. All levels of government must cooperate to broaden the control of infectious agents. Officials must consider needed research, constant surveillance and the effect of control measures on the ecology of the total environment.

Beyond the present control measures, research should be accelerated to help provide for better control of infectious agents. The application of old and new methods for pollution control such as proper animal waste disposal, sanitary landfill sites, surface runoff control, modified wet area management, exclusion of livestock from drainageways, reverse osmosis, and sterile-male techniques must be increased.

CONCLUSION

Land use planning and treatment must consider both pollutants originating on the land and alleviation of the pollution problems created by returning wastes to the land.

Silts, animal wastes, phosphates, chemical pesticides, and infectious agents are transported from the land to streams by runoff and sediment. To reduce runoff and sediment and ensuing water pollution, good conservation land treatment including protected drainageways must be applied at an accelerated rate to all watershed lands. Land can be more effectively used as a recipient of both agricultural and nonagricultural wastes, as a water filter and as a recycling media for otherwise waste resources.

Sediment from agricultural lands, processing wastes, fertilizer additives, pesticides and infectious agents are upstream pollutants for which established programs of research, surveillance, and controls may need to be augmented. Sediment from land undergoing urban development and animal wastes from confined livestock are generally unrecognized problems which can be expected to grow. Institutional control arrangements are needed to alleviate these growing problems.

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VII. GLOSSARY OF TERMS

NARS - APPENDIX L

Advanced waste treatment: Any treatment given to waste water in addition to the removal of 95% BOD and 98% suspended solids.

Assimilative capacity: The capacity of a natural body of water to receive: (a) wastewaters, without deleterious effects; (b) toxic materials, without damage to aquatic life or humans who consume the water; (c) BOD, within the prescribed dissolved oxygen limits.

Biochemical oxygen demand (BOD): The quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specified temperature, and under specified conditions.

Combined sewer: A sewer intended to receive both wastewater and storm or surface water.

Dissolved oxygen: The oxygen dissolved in water, wastewater or other liquid, usually expressed in milligrams per liter, parts per million or percent saturation.

<u>Effluent</u>: Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir, treatment plant, industrial plant, or part thereof.

Effluent criteria: The descriptive or numerical criteria which specifically limits the quality of the effluent discharged.

Nutrient control: The control of nutrient levels in receiving waters so as to prevent nuisance conditions.

<u>Pollution</u>: A change in the physical, chemical, or biological characteristics of water which makes the water unfit for its intended uses.

Population Equivalent (P.E.): An expression of the strength of organic material in wastewater. Domestic wastewater consumes, on an average, 0.17 lb. of oxygen per capita per day, as measured by the standard BOD test. This figure has been used to measure the strength of organic industrial waste in terms of an equivalent number of persons. For example, if an industry discharges 1,000 pounds of BOD per day, its waste is equivalent to the domestic wastewater from 6000 persons $(1,000 \div 0.17 = 6,000)$.

Primary treatment: The first major (sometimes the only) treatment in a wastewater treatment works, usually sedimentation. This means of treatment usually results in a BOD removal of 25% to 40% and a suspended solids removal of 40% to 60%.

River reach: A selected short segment of river mileage established to describe more specifically the water use and water quality of the particular river.

Secondary treatment: This is a series of treatments in a wastewater treatment plant which results in a 75 to 90% BOD removal and 70 to 90% suspended solids removal. The process usually consists of primary treatment plus a complete biological process followed by secondary settling.

<u>Sludge</u>: The accumulated solids separated from liquids, such as water or wastewater, during processing, or deposits on bottoms of streams or other bodies of water.

Tertiary treatment: Tertiary treatment is a third level treatment indicating that primary plus secondary treatment must be done before the third level of additional physical, chemical or biological process is done which would result in a total removal of 95 + % of BOD and 98 + % of suspended solids.

<u>Wastewater</u>: Any combination of the liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present.

Water quality: A term used to describe the chemical, physical, and biological characteristics of water and often used in conjunction with an expression of its suitability for a particular use.

<u>Water quality criteria</u>: The descriptive requirements which may contain numerical values of the limits of individual parameters used to evaluate the quality of a water body. Unless specifically designated otherwise, this refers to instream water quality criteria.

Water quality standards: Descriptions of the water quality established by each State water resources agency. As used in the NARS Report the term includes the descriptive legal regulations promulgated by the agency, the intended water uses, the water quality criteria, and the implementation timetable for treatment facilities.

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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY

APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 2

SUBREGION A

ENVIRONMENTAL PROTECTION AGENCY
WATER PROGRAMS OFFICE
May 1972

I. SUBREGION SUMMARY

- 1. Subregion A includes the entire State of Maine, with the exception of two southern counties, Cumberland and York. Subdivision of the study area has been on the basis of five distinct planning areas consisting of counties or groupings of counties rather than on the more familiar hydrologic basin breakdown. The major river systems covered, however, include the St. John, Penobscot, Kennebec, Androscoggin, St. Croix, and the Atlantic Coastal Basin from the International Boundary of the United States and Canada to Cape Small, Maine.
- 2. The economy of Subregion A is presently based on agriculture, and the pulp and paper, transportation, and service industries. Economic growth in this area is not expected to increase at the same rate as that for the remainder of New England. Because of its high ratio of employment in large water using industries, however, Subregion A will remain for some time a significant management problem in industrial water pollution control.
- 3. Water use within Subregion A includes municipal and industrial water supply, recreation, commercial fishing and navigation, power generation, irrigation and other legitimate uses. All of these uses, however, are hindered or restricted by the pollution that exists in the Subregion's surface waters. Presently municipalities and industries are the largest water users in Subregion A. In 1965 their combined use amounted to 391 mgd. Of this, over 84 percent or 330 mgd was required by the pulp and paper, food processing and textile industries. Estimates indicate that municipal and industrial water requirements will by 2020. As a result of the implementation of the water quality standards, a general trend toward increased use or multiple use of the surface waters of Subregion A can be expected.
- 4. Waste sources within Subregion A include non-industrial, industrial, combined sewers, septic tanks and cesspools, thermal, recreational and commercial navigation, rural and urban runoff, ocean disposal, construction activities and other types. Of these, non-industrial, industrial and combined sewer overflows are the most significant. One of the serious problems encountered in this study was the lack of easily accessible information concerning waste sources. Basic data such as locations of polluters, types of waste, waste strengths and flows, was often non-existent, old or contradictory.
- 5. Two hundred and eighty-three known industrial and non-industrial waste sources presently discharge 10,600,000 PE of BOD to the waters of Subregion A. Of this total, over 97 percent are contributed by industrial operations consisting of pulp and paper, textiles and food processing. The pulp and paper industry is the largest single source of pollution in Subregion A. Planning Area No.

- 2 currently receives the largest combined non-industrial and industrial waste load. Future non-industrial and industrial untreated waste loads will increase to 21,500,000 PE in 1980, 40,000,000 in 2000, and 74,100,000 in 2020. By 2020, industrial untreated waste will be over 70 times non-industrial. With secondary treatment these loads will be reduced to 3,200,000 PE in 1980, 4,000,000 in 2000, and 7,400,000 in 2020. In line with the present mix industrial wastes are expected to be over 95 percent of the total waste treated and discharged. Planning Area No. 2 will continue to receive the largest non-industrial and industrial waste loads.
- 6. Fifty-six known municipalities in Subregion A have combined sewer systems serving approximately 74 percent of the entire sewered population. These systems presently discharge these combined sewer flows to the waters of the Subregion. Neither the present or future volume or strength of this waste is known.
- 7. Major water quality problems presently occur throughout the Subregion. These problems occur on a general basis in Planning Areas No. 1, 2, 3 and 4 and to a limited extent in Planning Area No. 5. Planning Area No. 3 contains the greatest extent of surface water problems. The major problems are those associated with dissolved oxygen, coliform and nutrients and are caused primarily by the discharge of raw and partially treated non-industrial and industrial wastes. With full implementation of the water quality standards, including secondary treatment, severe water quality problems from non-industrial and industrial sources are not expected to occur on a general basis between 1980 and 2000. Local or limited problems which can be severe should be anticipated. Between 2000 and 2020, widespread violations of the existing standards should be expected if no more than secondary treatment is provided in Planning Areas No. 1, 2, 3 and very probably in Planning Areas No. 4 and 5.
- 8. Pollution control alternatives and needs for Subregion A are summarized below. A more detailed summary of these alternatives and needs are included in the body of the report.
 - a. Source control utilizing (1) new or improved process and treatment methods for the pulp and paper, food, textiles and electrical generation industries; (2) land and water use studies to determine the optimum river locations for future "wet process" industries; (3) efficient or entirely new concepts in collection and treatment methods for urban and rural wastes and combined sewer overflows; (4) the regulation of effluent discharges especially in the coastal waters adjacent to Planning Area No. 5. These methods of source control all entail a study need, as well as a research and development need.
 - b. Secondary treatment of all biodegradable wastes is required in Subregion A throughout the study period. Residual waste loads discharged to the streams after secondary treatment will

- be 3,200,000 PE in 1980, 4,000,000 in 2000, and 7,4000,000 in 2020. Wastes containing other than biodegradable material should receive a treatment with removal efficiencies similar to secondary. All effluents containing domestic or pathogenic organisms should be disinfected.
- c. Advanced wastewater treatment or low flow augmentation will not be required on a general basis throughout the Planning Areas until after 2000. Presently, however, there is a need for one or both of these alternatives at specific sites in Planning Areas No. 1, 2 and 3. Additional local needs for these alternatives should be anticipated and studies should be initiated to define local problems areas. Between 2000 and 2020, however, advanced wastewater treatment or low flow augmentation or both will be required on a widespread basis in Planning Areas No. 1, 2 and 5, and very probably in Planning Areas No. 3 and 4.
- d. The following studies are needed in addition to those already mentioned in (a) and (b) above. Studies to determine (1) existing and potential nutrient problem areas and the best method of handling these problems; (2) policies on the disposal of all wastes in international waters beyond the territorial limit of the United States (3 miles offshore), adjacent to Subregion A; (3) regional solutions to water quality problems; (4) the professional and technical manpower needs in the Subregion; (5) methods of better regulating control of the river flows; (6) the effectiveness of existing international, federal, state and interstate pollution laws; (7) the best ways of assembling and disseminating pollution data for federal, state and public use. In addition, Type II Water Resource Council Studies are needed in each Planning Area.
- e. Legal considerations include resolution of the present exceptions to the proposed standards taken by the Secretary of the Interior, strict enforcement of the standards, including adherance to established implementation schedules, boat pollution laws, mandatory certification of water pollution control facility operators, revision of the present construction grant allocation formula so as to more adequately meet the wastewater treatment plants needs of Subregion A and revisions to the water quality standards to upgrade certain waters. Other legal needs are discussed in detail in the body of the report.
- f. Research and development needs center about finding more effective and economical ways of (1) reducing and treating the pulp and paper, textile, food processing and thermal waste loads and (2) collecting and transporting waste loads in urban and rural areas.

g. Based on present methods and technology, the financial needs to control pollution over the study period in Subregion A are very high in relation to the population served. The cost of providing secondary treatment for the waste loads of the Subregion will approach \$1,603,000 by 2020. Control of combined sewer overflows is estimated at \$76,000,000 based on a one-time investment before 1980. Additional costs will also be required for operation and maintenance of these facilities as well as for needed construction of collection systems.

In order to raise the necessary funds over the 50 year study period in a practical and equitable way, there is a major need to examine the Federal, state and local participation requirements and the role which industry should play.

FIGURE A-1

MAP OF

SUBREGION A

LOCATION AND BOUNDARIES

(Located in back of book)

TABLE L-1(A)

SUBREGION A - PLANNING AREAS

Planning Area Number	Grouping of Whole Counties in the Planning Areas	Complete and Partial Major River Basins Within the Planning Area
1	Aroostook, Me.	St. John River, Me.
2	Penobscot, Me. Piscataquis, Me.	Penobscot River, Me.
3	Franklin, Me. Kennebec, Me. Somerset, Me.	Kennebec River, Me.
4	Androscoggin, Me. Oxford, Me.	Androscoggin River, Me. and N.H.
5	Hancock, Me. Knox, Me. Lincoln, Me. Sagadahoc, Me. Waldo, Me. Washington, Me.	St. Croix River and Atlantic Coastal Area from the Inter- national boundary to Cape Small, Maine

TABLE L-2(A)

SUBREGION A - MAJOR RIVERS AND TRIBUTARIES

River	Length (Miles)	Drainage Area (Square Miles)
ST. JOHN RIVER BASIN		- 1
St. John	215	$8,320\frac{a}{}$
Allagash	63	1,260
Fish	63	892 _b /
Aroostook	105	$^{2,440}b/$
PENOBSCOT RIVER BASIN		
Penobscot	105	8,570
West Branch Penobscot	97	2,100
East Branch Penobscot	47	1,100
Matawamkeag	48	1,490
Piscataquis	76	1,454
Passadumkeag	43	385
Kenduskeag	33	214
KENNEBEC RIVER BASIN		
Kennebec	145	5,870
Moose	76	735
Dead	23	878
Carrabasett	35	400
Sandy	69	593
Sebasticook	48	950
ANDROSCOGGIN RIVER BASIN		
Androscoggin	161	3,450
Magalloway	47	439
Ellis	20	163
Swift	25	125
Little Androscoggin	46	352
ST. CROIX RIVER AND ATLANTIC COASTAL		
AREA FROM INTL. BORDER TO CAPE SMALL, ME.		
St. Croix River	77	1,635
Atlantic Coastal Area		•
Machias River	32	450
Pleasant River	43	332
Union River	39	497

 $[\]underline{a}/$ U.S. and Canadian drainage areas at the International Border near Hamlin, Maine.

 $[\]underline{b}$ / U.S. drainage area at the International Border near Fort Fairfield, Maine.

II. DESCRIPTION OF SUBREGION

LOCATION AND BOUNDARIES

Subregion A is located in the northeasternmost part of the North Atlantic Regional Water Resource Study Area and lies entirely within the state of Maine. Maine's two southern counties, Cumberland and York, are not included within the limits of the Subregion. The geographical boundaries of Subregion A are shown in Figure A-1. This Subregion encompasses nearly half of New England, 29,000 square miles, and includes 2,000 square miles of inland surface waters and 1900 miles of coastline.

Subregion A was divided by the Coordinating Committee into five water resource planning areas delineated by county boundaries; each planning area consists of one or more whole counties. Table L-1(A) lists the areas, the counties, and the whole or partial river basins in each planning area.

PHYSICAL FEATURES

- 1. General Hydrology: The major river systems in Subregion A are the St. John, Penobscot, Kennebec, Androscoggin, Saint Croix and the Atlantic Coastal Area from the Canadian Boundary to Cape Small, Maine. The location of these river systems are shown in Figure A-1. With the exception of the St. John, these river systems flow in a south or southeasterly direction into the Atlantic Ocean. rivers have a drainage area in the United States of approximately 33,000 square miles. With the exception of the St. John River, all major rivers in Subregion A have extensive upstream storage impoundments. These are regulated by private interests for hydroelectric, industrial process water and log driving purposes. This regulation substantially augments natural river flows during summer and fall seasons with some beneficial effect on water quality. hydrologic information consisting of lengths and drainage areas for the major rivers and tributaries within Subregion A is presented in Table L-2(A). Detailed hydrologic data for these rivers are presented in Appendix C - Climate, Meterology and Hydrology of the NAR report.
- 2. General Geology: Subregion A has a wide variety of geological domains. Planning Area No. 5 is characterized by drowned river mouths, headlands, low-lands and landforms crested by glacial activity. The inland reaches of this area rise to create rolling hills that extend into the lower sections of Planning Areas No. 1, 2, and 3.

Planning Areas No. 3 and 4 are provided sharp relief by mountains which rise 3,000 or 4,000 feet above sea level to divide the

Androscoggin and Kennebec River Basins. Planning Area No. 2 is dotted with numerous lakes and poorly drained depressions which are dominated by the four thousand foot summit elevations of the Katahden Mountain system. The remainder of the Subregion is rough, forested upland. Much of the terrain and many of the streams in Subregion A are suitable for impoundments.

The overburden of Subregion A consists mainly of glacial till that may vary from shallow depths to thicknesses of approximately 500 feet. This unsorted material has been covered in many areas by glacial outwash and such landforms as kame, kame terraces, deltas and eskers. Specific information on the geology of Subregion A is given in Appendix D - Geology and Groundwater of the NAR Report.

CLIMATE

According to information presented in Appendix C - Climate, Meterology and Hydrology of the NAR Report, Subregion A has four distinct seasonal variations that cause temperature fluctuations in the average year of over 56°F in the north and about 40°F along the coast. Temperatures in the summer months are moderate. Average July temperatures range from 60°F to 68°F along the coast and from 68°F to 60°F inland with the exception of Planning Area No. 1 where temperatures average 64°F to 68°F. January temperatures average 24°F to 26°F along the coast and about 10°F in the extreme north.

Precipitation in the Subregion is well distributed throughout the year. Most of Subregion A receives 38" to 42" of rain annually, with substantially larger amounts in the mountains. Winter precipitation is in the form of snow which averages 70" to 100" from south to north and lasts about 60 days in the higher western and northern portions of the Subregion.

III. ECONOMY

ECONOMIC SUBAREAS

For study purposes, Subregion A was divided into five planning areas based on a political subdivision rather than a river basin breakdown. As a result, each planning area consists of whole counties or groups of whole counties. Table L-1(A) lists the areas, the counties and the whole or partial river basins therein.

SELECTED ECONOMIC MEASURES

Detailed economic data on Subregion A are presented in Appendix B - Economic Base of the NAR Report. Selected summary data are presented in Table L-3(A).

In 1960 the total population in this region was 687,000 and the population density was a relatively low 24 persons per square mile. By 2020, the Subregion's population is expected to be 1,050,000, an increase of 50 percent, which will result in a density of 36 persons per square mile. This low density forecast for 2020 indicates that the Subregion's rural character will not change appreciably over the next 50 years. By comparison with the other five major Subregions in the NAR, Subregion A has the smallest number of inhabitants, and the lowest total employment (242,000), per capita personal income (\$1,658), manufacturing employment (81,000), and selected industry employment (six major water using industries — food, textile, chemical, paper, petroleum and primary metals) 37,000.

Politically, the region encompasses only 14 counties, one Standard Metropolitan Statistical Area (Lewiston-Auburn), and four minor urban centers (community or municipality with a minimum population of 20,000).

Of the several economic measures under consideration, projected changes in the region's ratio of total factory employment to total labor force when compared with the same factors in the other NAR Subregions, point up the capacity to generate a strong manufacturing basis in this Subregion. Subregion A has the fourth highest ratio of the six Subregions with 333 factory workers per 1,000 employed. By 2020, it is anticipated that this Subregion will have the highest ratio in the NAR study area with 278 manufacturing employees per 1,000 totally employed. Although the ratio is projected to decline, the decrease in Subregion A is decidedly less than in any of the other five major NAR Subregions.

In terms of selected industry employment Subregion A had the highest concentration of employment in major water using industries in the study area and is expected to continue to lead in this

TABLE L-3(A)

SUBREGION A - SELECTED ECONOMIC MEASURES

ECONOMIC MEASURES	<u>1960</u>	1980	2000	2020
Population	687,000	769,000	897,000	1,050,800
Total Personal Income (\$000)	1,124,200	2,474,200	5,072,500	10,853,300
(1958 Dollars),				70 200
Per Capita Income ^a /	1,658	3,217	5,655	10,329
(1958 Dollars	-1- 100	200 000	252 200	/17 200
Total Employment	242,400	298,000	353,200	417,300
Agriculture + Forestry + Fisheries	18,100	12,800	9,700	7,100
Mining	200			
Total Manufacturing	80,700	96,600	103,000	116,000
Six Major Water-using Industries Total				
20 Food and Kindred Products	7,900	7,800	7,900	7,600
22 Textile Mill Products	12,300	9,000	7,100	5,800
26 Paper and Allied Products	15,500	19,400	23,500	27,800
28 Chemicals and Allied Products	1,000	1,500	2,100	3,200
29 Petroleum Refining	200	ъ/	<u>b</u> /	<u>b</u> /
33 Primary Metals	100	$\frac{1}{2}$ 00	200	200
All Other manufacturing Employment	43,700	54,700	62,300	71,400
Armed Forces (number)	12,400	11,000	11,000	11,000
All Other Employment Categories	131,000	181,600	229,500	283,200

a/ Based upon 1959 population and personal income reported in 1960 Decennial U.S. Census.

Source: North Atlantic Regional Water Resources Study, Appendix B, Economic Base,
Prepared by Office of Business Economics, Regional Economics Division, U.S. Department of
Commerce.

b/ Number insignificant.

relationship through 2020. On a subregion basis, Planning Area No. 4 which includes the Lewiston-Auburn Standard Metropolitan Statistical Area (SMSA) had the highest manufacturing to total employment (labor force) ratio of all 21 NAR Planning Areas in 1960, and is projected to maintain this position through 2020. Planning Area No. 1 and 2 of Subregion A have the highest ratio of selected employment to manufacturing employment both in 1960 and projected to 2020, of all NAR planning areas.

Although Subregion A is small relative to major economic measures, it compares well with other NAR Subregions in natural resources and beauty. Abundant woodlands, numerous lakes, camp sites, ski slopes and hundreds of miles of seashore make the Subregion a highly attractive year-round haven for vacationists and sports enthusiasts, as well as residents. As indicated in the text and tables, Subregion A, because of its high ratio of employment in large water-using industries, will remain for some time to come a significant management problem in industrial water pollution control.

IV. PRESENT AND FUTURE WATER USES

GENERAL

Subregion A is endowed with an abundance of water resources consisting of surface waters, coastal waters and ground water. Together they provide a variety of water uses. Their character and utilization will have a direct relationship to the present and future development of Subregion A.

General information that is intended to present a perspective of the existing and anticipated use of these waters in Subregion A, is presented in Table L-4(A). Analysis of this information indicates that all of the rivers shown are being used for water supply and this use will continue in all cases. Presently the coastal waters are the only waters being used to harvest shellfish, however, this use will be extended to the Penobscot River in the future. Several rivers, the Aroostook, Penobscot, Piscataquis, and Sandy, which are not presently utilized for bathing will see this recreation use restored in the future. The same general trend of increased uses or multiple use of the surface waters in the future is evident in the several cases of rivers presently without a fishing, water contact recreation, agriculture, industrial or navigation use.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY1

Municipal and industrial water use in Subregion A totaled 391 mgd in 1965 Municipal use, which includes that portion of industry served by municipal systems amounted to 71 mgd. The remaining 312 mgd was utilized by industry supplied from sources other than municipal.

Municipal water supply systems in Subregion A serve a population of over 511,000. The major industrial water users in Subregion A are the food, textile and paper industries. These industries account for nearly 100 percent of the industrial water use. These industries are all "wet processes" types and therefore have considerable impact on water quality in Subregion A.

Municipal and industrial water use will increase in Subregion A throughout the design period. Estimates indicate that the total municipal and industrial water needs will be 1153 mgd in 1980, 1764 mgd in 2000, and 2550 mgd in 2020. The major increases will probably occur in or about the present centers of population and industry.

^{1.} Source - NAR Report Appendix R, Present and Future Water Supply.

TABLE L-4(A) $\mbox{SUBREGION A - PRESENT AND FUTURE WATER USE} \frac{1}{2} / \frac{2}{2}$

Water Body		ate upp		Shel fish		Ва	atl	ning	Fis	shing		ic., Ind., vig. & mer
Legend x	=	Pr	esent	Use		0	=	Futi	ıre 🧎	Use		
			PLANN	TNC	V D II. V	1						
			LIMM	TING	AKLA	<u></u>						
ST. JOHN RIVER BASIN												
St. John River	X	o					x	0	X	o	x	o
Aroostook River	X	О						0	x	0	x	0
Limestone Stream	Х	О					X	0	х	0		0
Prestile Stream	x	o							х	0	x	О
Meduxnekeag River	x	o					X	0	x	0	x	0
			PLANN	ING	AREA	2						
PENOBSCOT RIVER BASIN												
Penobscot River	7.7	0		_							37	0
Piscataquis River		0		C	,			0		0	x x	
riscataquis River	х	U						O		U		U
			PLANN	ING	AREA	3						
KENNEBEC RIVER BASIN												
Kennebec River	x	О								0	x	o
Sandy River	х	О						0		0	x	0
Sebasticook River	х	0							x	0	x	o
			PLANN	ING	AREA	4						
ANDROCCOCCIN DIVER DAC	TNT											
ANDROSCOGGIN RIVER BAS Androscoggin River		0					v	0	v	0	v	0
Little Androscoggin							х	O		0		0
Sabattus River		0								0		0
Sabattus Kivei	^	Ü							^	U	^	O
			PLANN	ING	AREA	_5						
ST. CROIX RIVER & ATLA	NT:	IC										
COASTAL AREA from INTL		вог	RDER									
TO CAPE SMALL, ME.												
St. Croix River		О					X			O		0
Atlantic Coastal Are	a			х)		X	0	X	0	X	0

 $[\]underline{1}/$ Water uses are for the stream in general and not for any specific reach.

 $[\]underline{2}/$ Future uses are those called for in the water quality standards.

RECREATION

1. Bathing 1: In general, the inland and coastal waters of Subregion A are not warm enough to attract a large bathing use. This is especially true of the northern inland waters and the coastal waters, from Penobscot Bayy to the International Border. The coastal waters from Cape Small to Penobscot Bay receive medium bathing use. In spite of the relatively cool waters, however, almost 1 million people attended state parks throughout the state to swim and bathe during 1967.

Based on projected recreation activity, bathing will increase about 53% fold by 2020.

2. <u>Boating</u>²: Most of the boating in the Subregion is attributed to "resident" boaters. There are few marinas in the Subregion and only a limited number of docking facilities are available. The scarcity of boating facilities is attributed to high capital expense and a short season.

The total resident boat count is estimated to be 100,000, of which 87 percent are used for recreation. Of this, 66 percent use the inland waters and 34 percent use the coastal waters. Resident boater projections show an 8.5 to 11 percent increase per year over the next five years. The number of transient boats is not available.

Boating use in Subregion A will increase throughout the design period. Estimates indicate that boating use will about double by the year 2020.

3. Sport Fishing³: Sport fishing appears to be the most popular of water oriented sports in Subregion A. Because of the abundance of streams and inland lakes which support a cold water fishery, the Maine Environmental Improvement Commission has used fishery criteria as the governing factor in establishing water quality standards for most areas.

Trout fishing is by far the most popular type. Land locked salmon, perch, bass and pickerel are also popular sport fish. At one time, large numbers of Atlantic Salmon entered the coastal streams to spawn, but in recent decades dams and pollution have nearly eliminated this yearly migration. With the abatement of pollution and the construction of fish ladders, the restoration of Atlantic Salmon to the northeast part of Planning Area No. 5 probably would be successful.

^{1.} Source - NAR Report, Appendix M, "Recreation".

^{2.} Source - NAR Report, Appendix M, "Recreation".

^{3.} Source - NAR Report, Appendix O, "Fish and Wildlife".

Sport fishing in coastal waters is minimal, consisting of mackerel and striped bass. Some fishing for smelts occurs during the spring run.

The waters of Subregion A will be subjected to an increased fisheries use in the future. Estimates indicate that for the Subregion as a whole 6.1 million man-days will be devoted to fishing in 1980. This use will increase to 7.1 and 8.2 million man-days in 2000 and 2020, respectively.

4. Wildlife and Waterfowl¹: All of Subregion A abounds with many kinds of wildlife: white tailed deer, black bear, squirrels, and rabbits. The northern part of Subregion A, Planning Areas Nos. 1, 2, and part of 3, has such furbearers as beaver, mink and muskrat.

The entire Subregion provides summer nesting grounds for migratory waterfowl. The islands of Planning Area No. 5 abound with nesting birds and also serve as wintering grounds for ducks. As a result, waterfowl hunting is a popular sport in Planning Area No. 5.

Based on the number of million man days which can be expected to be devoted to wildlife hunting, Subregion A as a whole can expect a slight incremental increase for this water oriented sport in each of the design years 1980, 2000, 2020. Estimates indicate that in 1980 2.37 million man-days will be devoted to wildlife hunting. This will increase slightly to 2.79 in 2000 and 3.36 million man-days in 2020.

COMMERCIAL FISHING

Commercial fishing in Subregion A is limited to Planning Area No. 5. This fishing is limited to salt water species with lobsters and soft shelled clams being the major income producers. In fact, Maine is the largest producer of lobsters in the United States. Crabs and scallops have a limited commercial harvest. Herring are taken in season and support a sizeable shore-based sardine industry. Other fisheries of minor importance are smelts, alevines, and ocean perch. In recent years, some shrimp have been landed.

An unusual industry of some economic value is the harvesting of marine worms to be used as bait for sport fishermen.

During the past ten years many shellfishing areas have been closed as a result of steadily increasing pollution. In other marginal areas, clams must be subjected to depuration before sale.

Maine's Department of Sea and Shore Fisheries estimates that forty-five percent of the shellfish areas in the State suitable for commercial

^{1.} Source - NAR Report, Appendix O, "Fish and Wildlife".

harvesting have been closed to shellfishing because of pollution.

Future use of the waters of Subregion A for commercial fishing is not known at present; however, it can be conservatively assumed that this use will increase in the future. This is especially true in regard to the harvesting of shellfish. Many of the presently closed shellfish beds will become active producers when water pollution control facilities are constructed in numbers in the Subregion.

COMMERCIAL NAVIGATION 1

Commercial navigation in Subregion A is concentrated in the coastal parts of Rockland and Searsport and in the river ports of Bucksport and Bangor located on the Penobscot River. Both Rockland and Searsport are suitable for deep draft vessels.

Rockland is the Region's leading port for fish landings and the country's leading lobster port. Fish plants, packers, and lobster wholesalers handle almost 100 million pounds of seafood per year from Rockland.

Searsport is a popular petroleum port for deep ocean vessels and is located about thirty miles from the entrance to Penobscot Bay. In 1965, close to 1,200,000 tons of petroleum products were unloaded at this port. Searsport allows the transhipment of radioactive wastes.

Bucksport and Bangor located on the Penobscot accommodate shallow draft vessels about nine months of the year. During 1965 over 100,000 tons of liquid sulfur and 1,400,000 tons of petroleum products entered these river ports by tanker.

Commercial navigation will increase in Subregion A during all design years. Estimates indicate that the annual tonnages will be 4.6 in 1980, 8.1 in 2000, and 13.2 in 2020.

POWER GENERATION

1. Hydropower²: In 1960 there were sixty-eight individual hydroelectric power plants in Subregion A. Of these, thirty-eight were privately owned; twenty-seven were industrial; and three were public. Total installed hydroelectric capacity exceeded 400,000 KW and the average annual generation was over 2,000,000,000 KWH.

Estimates of future hydropower requirements in Subregion A

^{1.} Source - NAR Report, Appendix K, "Navigation".

^{2.} Source - NAR Report, Appendix P, "Power".

indicate that the demand for this type of power generation will be small. Total hydroelectric power requirements in Subregion A will be met with existing facilities.

2. Steam 1: As of 1966, there were three public utility steam generating power plants in Subregion A producing over 200,000 KW of electric power.

Presently the number and capacities of privately owned steam generating plants, such as exist at industrial installations, is not known.

One nuclear powered steam generating plant is presently under construction in Planning Area No. 5 at Wiscasset, Maine. This plant will have a capacity of 830 megawatts.

TRRIGATION

The use of water for irrigation purposes has been restricted mainly to Planning Area No. 1 in the Subregion. Present demands in the Subregion amount to 100 acre feet which is used for potato and sugar beet crops.

Estimates of future irrigation water requirements indicate present volumes will increase to 32,000 acre feet by the year 2020.

OTHER

In April 1968, the State of Maine granted a permit to King Resources Company allowing the company to begin offshore exploration for oil. The permit gives the company exploration rights over a 3.3 million acre tract that extends up to eighty miles from the coast. Drilling had not begun as of the end of 1969, however, the active interest of this one company in this venture indicates that oil drilling in the waters of Planning Area No. 5 of the Subregion is a distinct possibility.

^{1.} Source - NAR Report, Appendix P, "Power".

V. PRESENT AND FUTURE WASTE SOURCES

GENERAL

Raw, partially treated and treated waste loads from industrial and non-industrial sources amounting to 10,600,000 P.E.'s of BOD are presently discharged to the inland and coastal waters of Subregion A.

Of this total, industrial operations consisting of food (SIC 20), textiles (SIC 22) and paper (SIC 26) contribute 10,300,000 P.E.'s or 97 percent of the total discharged waste load. The pulp and paper industry is the largest single source of pollution in Subregion A. This industry discharges 86 percent of the combined non-industrial and industrial total.

Unless major changes are made in plant processes at the point of origin or shifts in growth patterns, future non-industrial and industrial untreated waste loads will increase to 21,500,00 P.E.'s in 1980, 40,000,000 in 2000, and 74,100,000 in 2020. With secondary treatment these waste loads will be reduced to 3,200,000 P.E.'s in 1980, 4,000,000 in 2020, and 7,400,000 in 2020 and be discharged to the waters of the region. In line with the present mix, industrial wastes are expected to represent over 95 percent of the total industrial and non-industrial waste load treated and discharged.

Other types of waste sources exist in Subregion A although they may presently be overshadowed by the non-industrial and industrial types. Detailed information concerning these as well as non-industrial and industrial sources is presented in the following subparagraphs.

NON-INDUSTRIAL AND INDUSTRIAL WASTES

1. <u>Non-Industrial Waste Loads</u>: There are 182 known municipal, institutional and Federal waste sources which discharge to the surface waters of Subregion A. These wastes exert a biochemical oxygen demand on these waters of approximately 300,000 population equivalents. Selected information concerning these sources is summarized in Table L-5(A).

In 1960 the total population of Subregion A was estimated to be 687,000 with 50 percent or 340,000 people being served by municipal systems. The waste from about 80 percent of the 340,000 people served by municipal systems was discharged to the waters of Subregion A without receiving any treatment, 14 percent received primary treatment, and 5 percent received disinfection. The cities of Caribou in Planning Area No. 1, Bangor in Planning Area No. 2, and Lewiston in Planning Area No. 4, contribute over 20 percent of the total non-industrial waste in the Subregion. Forty-five Federal sources contribute less

TABLE L-5(A)

SUBREGION A - ESTIMATED PRESENT NON-INDUSTRIAL DISCHARGES*

		D E G	REE	OF	TRE	ATMEN		Systems	Systems	Combined
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated	Not Chlor- inating	Storm- Sewer Systems
1										
Number of Systems	20	3	9	4.		4			19	5
Pop. Served (000)	56	1	20	21		14			48	5 27
Waste Load Disch.		_				32.1			40	27
Calc. P.E. (000)	36		20	14		2				
2										
Number of Systems	31	6	23	2					31	13
Pop. Served (000)	73	1	70	2					73	61
Waste Load Disch.									, 3	OI.
Calc. P.E. (000)	71		70	1						
3										
Number of Systems	33	3	23	6		1			31	15
Pop. Served (000)	84	1	61	21		1 1			66	71
Waste Load Disch.										· .
Calc. P.E. (000)	75		61	14				•		
4										
Number of Systems	19	1	18						19	7
Pop. Served (000) Waste Load Disch.	72		72						72	61
Calc. P.E. (000)	72		72							

^{*}Includes waste loads from municipalities, institutions and Federal installations.

TABLE L-5(A) (Continued)

SUBREGION A - ESTIMATED PRESENT NON-INDUSTRIAL DISCHARGES*

		DEG	REI	OF	TRE	ATMEN		Systems	Systems	Combined
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated	Not Chlor- inating	Storm- Sewer Systems
5										
Number of Systems	79	5	65	6		3			77	16
Pop. Served (000)	56	1	49	5		1			56	36
Waste Load Disch.										
Calc. P.E. (000)	52		49	3		•				
Subregion Total										
Number of Systems	182	18	138	18		8			177	56
Pop. Served (000)	341	4	272	49		16			315	256
Waste Load Disch.										
Calc. P.E. (000)	306		272	32		2				

^{*}Includes waste loads from municipalities, institutions and Federal installations.

than 1 percent of the total non-industrial waste load.

Based on population projections, untreated non-industrial waste loads in Subregion A will increase to 760,000 P.E.'s in 1980, 870,000 in 2000, and 1,000,000 in 2020. Non-industrial waste loads which are composed of population only will almost double during the study period. This type of growth is in line with similar conditions in Subregion B. Information concerning non-industrial and industrial waste loads is summarized in Table L-7(A).

Secondary treated non-industrial waste loads are estimated to be 12,000 P.E.'s in 1980, 90,000 in 2000, and 100,000 in 2020. Secondary treated non-industrial effluents will comprise less than 5 percent of the combined total of non-industrial and industrial effluents of the future.

2. <u>Industrial Waste Loads</u>: Untreated and partially treated wastes from 101 known industrial sources exert a biochemical oxygen demand on the surface waters of Subregion A of approximately 10,300,000 population equivalents.

Selected information concerning these sources was obtained from various published reports prepared by federal and state water pollution control agencies and is summarized in Table L-6(A).

Manufacturing and processing operations of the food, textile, paper and pulp industries contribute significant quantities of oxygen demanding wastes to the surface waters of the area. Paper manufacturing waste exerted the greatest oxygen demand on the waters in the Subregion, 9.1 million population equivalents. This represents 88 percent of the total industrial waste load and is roughly 30 times the combined waste load discharge of all municipal, institutional and federal sources. Pulp and paper wastes are extremely heavy in Planning Areas No. 1, 2, 3, 4. Of the remaining 1,200,000 P.E.'s of organic waste discharged by industry, approximately 970,000 were contributed by the food industry with over 860,000 P.E.'s of this amount being deposited in the surface waters of Planning Area No. 1.

Inorganic waste loads were discharged by at least two operations in the primary metals industry. Their effect on water quality, however, is minor.

Of the 101 sources of industrial wastes in Table L-6(A), 85 did not provide any treatment, only 14 offered partial treatment of the wastes, and only one provided complete treatment.

Based on an industrial activity, untreated industrial waste loads in Subregion A will increase to 20,800,000 P.E.'s in 1980, 39,100,000 in 2020, and 73,100,000 in 2020. These values are summarized in Table L-7(A). Analysis of this information shows that untreated industrial waste loads will increase 7 times during the

TABLE L-6(A)

SUBREGION A - ESTIMATED PRESENT INDUSTRIAL WASTES

SUMMARY

2 D	igit SIC Group	Waste Load Before Treat. (Est. P.E.)	Number of Known Sources	W A	A D E Q S T E Partial	U A C Y T R E A T Complete	O F M E N T Unknown	Discharged Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
20	Food Water Use MGD	1,115,000	50	35	14	1		972,000	SS ¹ /, Grease, Oil, Disease- Bacteria
22	Textiles Water Use MGD	214,000	23	23				214,000	SS, Color
26	Paper Water Use MGD	9,105,000	26	26				9,105,000	SS, Color, pH
28	Chemicals Water Use MGD	·	1				1		SS, Color, Oil, pH, Grease, Toxic Materials
29	Petroleum Water Use MGD								SS, Oil, Grease
33	Primary Metals Water Use MGD		1		1				Toxic Metals, pH, SS, Oil
Sub	region Total Water Use MGD	10,434,000	101	85	14	1	1	10,291,000	

 $[\]underline{1}$ / SS - Suspended solids.

TABLE L-7(A) SUBREGION A - PRESENT AND FUTURE ORGANIC WASTE LOADS

	Non-Industrial Waste Load, <u>a</u> / (P.E.) 000			strial Load, <u>b</u> / .) 000	Total Waste Load, (P.E.) 000		
Year	Before Treatment	After Treatment ^c /	Before Treatment	After Treatment	Before Treatment	After Treatment	
1960	106 <u>d</u> /	36	2,133	1,994	2,239	2,030	
1980	118	18	4,500	675	4,618	693	
2000	138	14	8,750	875	8,888	889	
2020	161	16	16,600	1,660	16,761	1,676	

Includes waste loads from municipalities, institutions and Federal Installations.

Includes the waste loads from the six major water-using two digit SIC groups. <u>b</u>/

Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.

Includes 50,000 persons not served by non-industrial waster collection system.

2020

TABLE L-7(A)

SUBREGION A - PRESENT AND FUTURE ORGANIC WASTE LOADS

PLANNING AREA NO. 2

Industrial Waste Load, b

2,926

Total

29,483

Waste Load,

2,948

(P.E.) 000 (P.E.) 000 (P.E.) 000 After Before After Before After Before Treatment Year Treatment Treatment Treatmen Treatment 142<u>d</u>/ 3,407 3,336 1960 71 3,265 3,265 1,085 7,394 1,109 1980 159 24 7,235 14,876 1,488 15,062 1,506 2000 186 19

29,264

Non-Industrial

22

Waste Load, a

219

a/ Includes waste loads from municipalities, institutions and Federal Installations.

b/ Includes the waste loads from the six major water-using two digit SIC groups.

c/ Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.

d/ Includes 69,000 persons not served by non-industrial waster collection system.

TABLE L-7(A)

SUBREGION A - PRESENT AND FUTURE ORGANIC WASTE LOADS

Industrial

Waste Load,

Total

Waste Load,

(P.E.		.) 000	(P.E	.) 000	(P.E.) 000		
Year	Before Treatment	After Treatment	Before Treatment	After Treatment ^c /	Before Treatment	After Treatment ^c /	
1960	₁₄₉ <u>d</u> /	75	1,586	1,586	1,735	1,661	
1980	167	25	2,743	412	2,910	437	
2000	189	19	4,504	450	4,693	469	
2020	217	22	7.657	766	7.874	787	

- a/ Includes waste loads from municipalities, institutions and Federal Installations.
- b/ Includes the waste loads from the six major water-using two digit SIC groups.

Non-Industrial

Waste Load, a

- c/ Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.
- \underline{d} / Includes 65,000 persons not served by non-industrial waster collection system.

TABLE L-7(A)

SUBREGION A - PRESENT AND FUTURE ORGANIC WASTE LOADS

Waste Load, D

Total

Waste Load,

(P.E.) 000 (P.E.) 000 (P.E.) 000 Before After After Before After Before Treatment c Treatment c Treatment Treatment Treatment Year Treatment 131<u>d</u>/ 2,563 2,491 2,623 2,492 72 1960 663 4,421 22 4,277 641 1980 144 7,152 6,997 700 715 155 16 2000 1,205 11,867 1,187 12,050 183 18 2020

- a/ Includes waste loads from municipalities, institutions and Federal Installations.
- b/ Includes the waste loads from the six major water-using two digit SIC groups.

Non-Industrial

Waste Load, a/

- c/ Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.
- d/ Includes 59,000 persons not served by non-industrial waster collection system.

TABLE L-7(A) SUBREGION A - PRESENT AND FUTURE ORGANIC WASTE LOADS

	Non-Industrial Waste Load, <u>a</u> / (P.E.) 000			strial Load, <u>b</u> /	Total Waste Load, (P.E.) 000		
Year	Before Treatment	After Treatment ^c /	Before Treatment	After Treatment	Before Treatment	After Treatment ^c /	
1960	159 <u>d</u> /	52	, 958	955	1,117	1,007	
1980	175	26	2,016	303	2,191	329	
2000	205	20	3,996	400	4,201	420	
2020	240	24	7,713	771	7,953	795	

- Includes waste loads from municipalities, institutions and Federal Installations.
- Includes the waste loads from the six major water-using two digit SIC groups.
- Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.
- Includes 103,000 persons not served by non-industrial waster collection system.

period 1960 - 2020. In this regard, Planning Area No. 2 will have the largest industrial untreated waste load in the Subregion.

Secondary wastewater treatment of future raw industrial waste loads will produce treated effluents of 3,100,000 P.E.'s in 1980, 3,900,000 in 2000, and 7,300,000 in 2020. Throughout the study period, over 95 percent of all non-industrial and industrial waste loads treated in Subregion A will be from industries rather than municipalities.

COMBINED SEWER SYSTEMS

Stormwater and municipal wastewater are presently collected, transported and discharged through combined sewer systems in 56 known municipalities within Subregion A. These combined sewer systems serve an estimated 260,000 people or approximately 74 percent of the entire sewered population presently discharging waste loads to the surface waters of Subregion A. The greatest numbers of combined systems occur in Planning Areas No. 2, 3 and 5. Presently, information is not available to estimate the amounts of wastewater which these systems discharge to the waters of Subregion A.

SEPTIC TANKS AND CESSPOOLS

Within the Subregion there are more than 87,000 separate housing units, as well as an unknown number of business establishments, which dispose of waste through septic tanks or cesspool systems. Because the natural overburden in the Subregion is of glacial origin and a large percentage of the area is covered with impervious soil types, septic tanks and cesspool systems often fail to provide adequate treatment.

Except in the vicinity of the relatively few urban areas and rural communities, sub-surface disposal methods can be expected to increase in numbers throughout the study period. Recreational home developments abutting the fresh water lakes and ponds, as well as the coastal waters, will be the cause of serious pollution loads in the future. Septic tanks and cesspools are being used to service these developments rather than municipal sewer systems and secondary treatment plants.

MINE DRAINAGE

At present there are no significant qualities of acid mine drainage waste loads reaching the surface waters of Subregion A. Recently, however, a copper extraction operation has been initiated in Planning Area No. 5.

Future waste loads from acid mine drainage in Subregion A are not presently contemplated. At the operation mentioned above, the Maine Environmental Commission and EPA have recently completed a study aimed at establishing present levels of trace metals in the waters surrounding this operation. This information can be used to assess any future change in these waters.

THERMAL SOURCES

Although information concerning the present numbers of thermal sources is not available for the Subregion, approximately 233 billion gallons of water were utilized by manufacturing concerns for cooling and condensing purposes in Maine during 1963. As of 1966, there were three public utility steam generating power plants in Subregion A producing about 223,000 KW of electric power.

However, in Planning Area No. 5 the Maine Yankee Atomic Company has under construction a nuclear plant at Wiscasset, Maine, with a capacity of approximately 860 megawatts. It is estimated that the temperature increase of the cooling water will be 25°F over that of the intake. This type of steam producer requires tremendous quantities of cooling water and is expected to produce a large share of electric power generation in the future. In 1965, nuclear fueled steam generating plants only contributed about 2 percent of the total power produced by public utilities in New England. In the year 2020, nuclear fueled types should account for approximately 75 percent.

RECREATIONAL AND COMMERCIAL NAVIGATION

Recreational boats, commercial vessels, and associated share facilities are possible sources of pollution of the surface waters of Subregion A, but the magnitude of this problem is unknown.

During 1965, the State of Maine issued registration numbers to approximately 40,000 recreational craft having engines of more than 10 horsepower. In this Subregion, pollution caused by recreational boating usually occurs on weekends, holidays and vacation periods of the late spring, summer and early fall. These boats usually concentrate in coves, inlets and other areas which are used for water contact sports, thus, increasing the health hazards from this type of pollution.

According to Appendix K, "Navigation" of the NAR Report, commercial navigation in Subregion A is restricted mainly to the Penobscot River ports (Bucksport, Bangor, Brewer) and Searsport. The principal cargo is oil and oil products. The greatest danger from this type of traffic lies in the possibility of a massive oil pollution incident. During 1969, there was 1 major and 3 minor oil spills in waters of Subregion A that required EPA envolvement. In addition, there were 9

minor violations envolving the U.S.C.G. only.

Future waste loads from recreational and commercial navigation can be expected to increase throughout the study period.

RURAL AND URBAN RUNOFF

Information is not available which accurately portrays the magnitude or types of waste loads that are being discharged to the surface waters of Subregion A by rural and urban runoff. The following information is presented, however, in order that some feeling for these waste loads may be obtained.

During 1959, approximately 147,000 tons of commercial grade fertilizers were spread on 247,000 acres of some 15,000 farms in the rural areas of the Subregion. The largest use of fertilizers was concentrated in Planning Area No. 1 where approximately 118,000 tons of fertilizers were spread over 155,000 acres of land. Pesticides are another ingredient of rural runoff. Pesticides are usually prepared and mixed in the fields utilizing water drawn from small farm ponds, brooks, or sump holes. Indiscriminate spillage of sprays and the improper disposal of containers containing pesticides can cause serious pollution problems. Forestry operations in Subregion A contribute soil erosion and some herbicides to the rural runoff in the area.

Urban runoff has become a source of pollution that is reaching the surface waters of the Subregion. Data are not available to indicate the magnitude of this load but each year additional acres of land are withdrawn from agriculture or other use patterns for urban development. A good portion of these once relatively pervious lands are then covered with impervious material with a resulting high degree of runoff to the surface waters. Urban runoff contains oils, organic matter, trash, soils, fertilizers and whatever else can be easily swept or washed into the street gutter or watercourse. These wastes cause an oxygen demand on the receiving waters, as well as an increase in amount of oil scums and suspended solids in these waters.

Both rural and urban runoff will continue to be significant waste load sources during the study period.

OCEAN DISPOSAL

The coastal waters of Subregion A (territorial waters of U.S.-3 miles offshore) receive untreated or partially treated waste loads from municipalities and industries, but at present the international waters, including the contiguous zone (3-12 miles offshore) are not being used to any appreciable extent for the disposal of waste loads. An insignificant volume of excavated spoil is being deposited in these waters at the present time.

Pressures for the disposal of waste loads in ocean areas, in the future, can be expected to increase throughout the study period. This will be especially true for exotic and dangerous types, as well as for the sludges, solids, and salts from secondary and advanced wastewater facilities.

CONSTRUCTION ACTIVITIES

Information concerning the magnitude of waste loads originating from construction activities in Subregion A isn't known at present. Earth moving operations associated with the construction of highways, airfields, real estate developments, navigation channels, marine terminals, water resource projects, including wastewater treatment facilities, and agriculture and forestry operations, can expose soils which are easily eroded by wind and water. Without careful controls during the life of the construction project, serious sedimentation problems can result.

An increase in the number of waste load sources associated with construction operations should be anticipated in Subregion A throughout the study period.

VI. PRESENT AND FUTURE WATER QUALITY PROBLEMS

GENERAL

Major water quality problems occur on many of the rivers of Subregion A. Raw and inadequately treated non-industrial and industrial waste loads are presently the overwhelming cause of these problems. Problems associated with dissolved oxygen and coliform levels, nutrients and sedimentation are all related to the discharge of these non-industrial and industrial wastes. Additional waste loads from combined sewers, septic tanks and other sources add to these problems in varying degrees throughout the Subregion.

Assuming that non-industrial and industrial waste loads receive secondary wastewater treatment, widespread water quality problems should not occur until 2000; however, limited problems may be expected throughout the study period due to the discharge of secondary treated non-industrial and industrial waste loads, combined sewer overflows, septic tanks and cesspool effluents, thermal waste loads, oil pollution, problems associated with recreational and commercial navigation, ocean disposal of sludges and exotic wastes.

Information concerning the present and future water quality problems of the Subregion is presented in detail in the following paragraphs.

NON-INDUSTRIAL AND INDUSTRIAL WASTES

Raw, partially treated and treated waste loads from non-industrial and industrial waste load sources amounting to 10,600,000 P.E.'s are presently discharged to the inland and coastal waters of Subregion A. As a result, major reaches of several of the rivers in the Subregion are seriously degraded. Figure A-2 shows the surface waters within the Subregion where non-industrial and industrial waste loads presently cause serious water quality problems. Rivers and surface waters with water quality problems associated with these types of waste loads are tabulated in Table L-8(A).

Water quality problems associated with dissolved oxygen and coliform levels resulting from the discharge of industrial and non-industrial wastes presently occur in Planning Area No. 1 on the St. John below Madawaska, on the Fish below Eagle Lake, the Aroostook below Washburn and on the Prestile and the Meduxnekeags. Similarly in Planning Area No. 2, the Penobscot below Millinocket and the Piscataquis below Guilford are in a degraded condition. In Planning Area No. 3, the Kennebec below Madison, the Sebasticook below Dexter and the Carrabasett below Kingfield have significant water quality problems. The Androscoggin is seriously degraded as it enters Planning Area No. 4 at Gilead, N.H. This condition occurs as a result

FIGURE A-2

MAP OF

SUBREGION A

WATER QUALITY PROBLEM AREAS

(Located in back of book)

TABLE L-8(A)

SUBREGION A - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus- trial-/	Indus-, trial	Thermal2/	Septic Tanks & Cesspools	Naviga- tion ³ /	Acid Mine Drain- age	Runoff ^{4/}	Other 5/
			PLANNING A	REA NO. 1				
ST. JOHN RIVER BASIN								
St. John River	x	x					x	
Fish		x						Ъ
Aroostook	x	x					x	Ъ
Prestile St.	x	X					x	С
Meduxnekeag	x	x			•		х	Ъ
			PLANNING A	REA NO. 2				
PENOBSCOT RIVER BASIN								
Penobscot River	x	х			x			
Fish St.		x						
Piscataquis	x	х						
Sebec	x							
Pleasant	x							
Lake Sebasticook	x							Ъ

TABLE L-8(A)

SUBREGION A - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus- trial ¹ /	Indus- trial	Thermal $\frac{2}{}$	Septic Tanks & Cesspools	Naviga- tion3/	Acid Mine Drain- age	Runoff4/	Other 5/
			PLANNING A	AREA NO. 3				
KENNEBEC RIVER BASIN								
Kennebec River	x	X			x			
Carrabasset	x	x						
Sandy	x	X						
Sebasticook	x	x						
Outlet St.	x	x						
Togus St.	x							
Lake Annabessacok								Ъ
			PLANNING A	AREA NO. 4				
ANDROSCOGGIN RIVER BASIN								
Androscoggin River Little	x	x						
Androscoggin	x	Х		x				
Sabbatus				x				

TABLE L-8(A)

SUBREGION A - KNOWN WATER POLLUTION PROBLEMS

	Non- Indus- trial ¹ /	Indus- trial	Thermal2/	Septic Tanks & Cesspools	Naviga- tion <u>3</u> /	Acid Mine Drain- age	Runoff4/	Other ⁵
			PLANNING A	REA NO. 5				
ST. CROIX RIVER AND ATLANTIC COASTAL AREA FROM INTL. BORDER TO CAPE SMALL, ME.							_	
St. Croix	x	х					x	
Atlantic Coastal Area	X	X			X			

- 1. Includes wastewater from municipalities, institutions, and Federal installations.
- 2. Includes thermal wastes from industry and thermal power plants.
- 3. Includes all types of wastes from commercial, recreational and Federal navigation.
- 4. Wastewater containing: (a) agricultural chemicals; and (b) sediment from agricultural and urbanization or industrial operations.
- 5. a. combined sewer systems
 - b. nutrient enriched water
 - c. inadequate dilution
 - d. suspect

of the discharge of large quantities of non-industrial and industrial waste loads below Berlin, N.H. The Androscoggin from Gilead to Lisbon, and the Little Androscoggin in its lower reaches, are badly degraded in Planning Area No. 4. Planning Area No. 5 has localized rather than widespread water quality problems.

Nutrient problem areas were found to occur in Planning Area No. 1 along the St. John, Aroostook, Meduxnekeag and Fish Rivers, in Planning Area No. 2 in Lake Sebasticook, along the Kennebec, Sandy and Sebasticook Rivers and in Lake Annabessacok in Planning Area No. 3 and in the Little Androscoggin in Planning Area No. 4.

Sedimentation problems occur as a result of the pulp and paper, textile and food processing operations. Reservoirs and shallow reaches of the major rivers and tributaries have ample evidence of benthic deposits and sludge banks caused by the sedimentation of wood, textile and food solids.

Future water quality problem areas in Subregion A were derived using the procedure described in detail in Chapter 1 of this Appendix. Briefly, it was assumed that by 1980 all waste loads sources would receive secondary treatment, and the resulting water quality would be at least equal to that called for by the State and Federal Water Quality Standards. Residual waste loads after secondary treatment in the year 2000 and 2020 were compared with the 1980 waste loads after secondary treatment. If the residual was more than twice that of 1980, it was assumed that without additional treatment, widespread violations of the existing water quality standards would occur and. therefore, advanced waste treatment or low flow augmentation would be required on a general basis. Where residual waste loads in 2000 and 2020 are greater than similar loads in 1980 by a factor less than two but greater than one, it was assumed that violations of the water quality standards would occur; however, these violations would be limited in extent. Advanced wastewater treatment or low flow augmentation or both would be needed to reduce residual loads to 1980 levels to maintain existing water quality standards. Detailed studies would be needed to accurately determine this need. The following is a list of such factors developed from this procedure and the secondary treated waste loads shown in Table L-7(A) for each Planning Area.

Planning Area	1980	2000	2020
1	1.0	1.3	2.4
2	1.0	1.4	2.7
3	1.0	1.1	1.8
4	1.0	1.1	1.8
5	1.0	1.3	2.4

The above procedure indicates widespread problems and violations of

the present water quality standards will not occur between 1980 and 2000 as a result of the secondary treated non-industrial and industrial waste discharges. Limited problems, however, should be expected in all Planning Areas of Subregion A. Detailed studies to accurately define the location and magnitude of these problems should be initiated. Widespread problems and violations of the present water quality standards can be expected between 2000 and 2020 in Planning Area Nos. 1, 2, 3, and very probably in Nos. 3 and 4, without proper remedial action.

The problems presently anticipated throughout the study period from the discharge of secondary treated non-industrial and industrial waste loads will involve mainly dissolved oxygen and nutrient levels. These problems should occur near present centers of population and industry.

COMBINED SEWER SYSTEMS

Presently 56 combined sewer systems serving 256,000 people collect, transport and discharge non-industrial, industrial and storm water waste loads in Subregion A. These wastewater discharges are felt to be the causes of water quality problems, although at present information is not available which accurately locates or adequately defines these problems. For purposes of this study, water quality problems associated with combined sewer overflows have been assumed to exist near municipalities presently having combined systems.

Future problems resulting from combined sewer overflows can be expected to increase throughout the study period as additional municipal waste due to population and economic growth is carried by the existing combined sewer systems. At present there is no generally accepted method of handling combined sewer overflows. Numerous research and development projects, however, are currently underway on this subject which, it is expected, will result in more complete information and the development of feasible solutions to this problem early in the study period.

SEPTIC TANKS AND CESSPOOLS

Water quality problems associated with septic tanks and cesspools are presently known to occur along the Little Androscoggin and Sabbatus Rivers. Undoubtedly there are other areas where this type of subsurface disposal system is also causing water quality problems at present. This is particularly true where lake front and coastal real estate developments are taking place at present.

Based on population increase and recreational development activity in the Subregion, future water quality problems from septic tanks and cesspools should be anticipated throughout the study period.

These problems can be expected to occur in the suburbs of the larger cities and towns in the Subregion as well as near recreational lakes and coastal waters.

MINE DRAINAGE

Mine drainage is not known to be causing any water quality problems in Subregion A at present.

Future water quality problems from mine drainage are not anticipated in Subregion A.

THERMAL SOURCES

Water quality problem areas occurring as a direct result of thermal pollution are not presently known. Manufacturing and utility plants do discharge hot cooling water to the rivers and coastal waters of the Subregion; however, the lack of specific numerical temperature data in the water quality standards of the Subregion make the definition of thermal pollution and related water quality problems difficult.

The Subregion should expect water quality problems only in Planning Area No. 5 from the discharge of thermal effluents. Strict controls could be implemented to minimize these problems.

RECREATIONAL AND COMMERCIAL NAVIGATION

Water quality prob ems specifically related to recreational navigation wastes appear to be periodic and localized in Subregion A at present.

Problems associated with commercial navigation are present in several of the rivers and coastal waters. Bangor in Planning Area No. 2, Rockland, Searsport and Bucksport in Planning Area No. 5, all have adjacent waters which are degraded by commercial navigation.

Water quality problem areas associated with recreational and commercial navigation will probably occur throughout the study period. The most serious of these problems will be oil pollution and this type of problem will occur predominantly in the coastal water of Planning Area No. 5.

RURAL AND URBAN RUNOFF

The most serious water quality problem associated with rural and urban runoff presently occurs in Planning Area No. 1 along the St.

John River. Rural runoff near Fort Kent and Van Buren is responsible for the loss of up to 20 inches of topsoil during the last 25 years.

Urban runoff, on the other hand, is not known to be the cause of water quality problem areas in Subregion A at present. Salt, a component of both urban and rural runoff used for snow and ice removal, is responsible for a general lowering of water quality in all Planning Areas.

The rural nature of Subregion A is not expected to change appreciably and the economy of the area will continue to be centered around agriculture, forestry and recreation activities. For this reason, rural rather than urban runoff will continue to be the major cause of this kind of water quality problem.

OCEAN DISPOSAL

Ocean disposal is not causing any known water quality problems in Subregion A at present.

Future problems related to this activity should be anticipated and planned for. Unless restrictions are adopted, the coastal waters of Planning Area No. 5 could easily become degraded as a result of receiving the salts, brines, sludges and exotic wastes of the future.

CONSTRUCTION ACTIVITIES

Presently, there are not any known water quality problems of serious magnitude in Subregion A.

Future water quality problems can be expected to occur, however, throughout the study period.

VII. POLLUTION CONTROL ALTERNATIVES

SOURCE CONTROL

Prevention or controls of waste at its point of origin is a practical means of reducing pollution. The development of new or improved industrial in-plant methods for the "wet process" industries of the Subregion, the collection of wastes in urban and rural areas for subsequent treatment, and the regulation of effluent discharges are all important pollution control alternatives that can prevent the degradation of the surface waters of this Subregion.

New industrial processes or refinements in existing methods aimed at reducing the amounts of untreated waste generated at the source can result in a significant reduction in the amount of wastewater treatment plant capacity needed, as well as contributing to the upgrading of the waters of the Subregion. New technologies should be developed which are aimed at removing the pulp and paper, food processing and textile operations from their historical positions as "wet process" industries to "dry process" industries. Similarly technological advances in the electrical generation industry are needed so that "cooling water" needs are reduced sharply. As shown in Table L-7(A), the untreated industrial waste loads are expected to approach 20,800,000 PE in 1980, 39,100,000 PE in 2000, and 73,100,000 PE in 2020. The untreated industrial waste load in 2020 will be over 70 times the untreated non-industrial. Assuming that process changes could reduce these loads by only five percent, 1,000,000 PE in 1980. 2,000,000 PE in 2000 and 3,700,000 PE in 2020 wouldn't require treat-The savings in wastewater treatment plant construction over the study period is considerable. Cost estimates developed and discussed in Subparagraph D below, found that the 1967 average price of providing secondary wastewater treatment for all of Subregion A for the waste loads of the three target years during the study varied as follows: \$10/PE in 1980, \$12/PE in 2000 and 2020, respectively. Based on these figures and the five percent assumed reduction in untreated waste loads, process changes would represent a savings of over \$78,000,000 in wastewater treatment plant construction cost over the study period.

The cities and towns of Subregion A need a practical and economical method of controlling combined sewer overflows. Present methods and costs are such that any serious effort to control these overflows is most likely to occur only in areas of intensive water use where overflows are frequent. Alternate methods of control include separation of storm and sanitary systems, interception and partial treatment, and interception and discharge to a larger body of receiving water. Estimates discussed in paragraph D indicate that with present day methods, an investment of \$76,000,000 would be required to control present discharges.

Many of the cities and towns have old and deteriorating collection systems, some of which date back to the early 1900's. They often carry large volumes of groundwater infiltration and sometimes transport their wastes to multiple outfalls. Methods of preventing or controlling groundwater infiltration in collection systems would increase the useable capacity or efficiency of the systems and also of the required wastewater treatment plants. Although there aren't any estimates available to show the savings involved, the reduction is felt to be considerable. This is especially true in regard to reduced capital and operating costs for wastewater treatment plants. The installation of interceptors, capable of cutting off the present use of multiple outlets and conveying these wastes to a central point for treatment, is needed to eliminate raw waste discharges to the receiving waters.

Collection systems also can be extended to prevent pollution at the source, especially in high population density sectors in both urban and rural areas. Where development is proceeding at a rapid rate, builders should be required to install collection systems before local officials issue building permits. This concept is especially important on land bordering recreational ponds, lakes, rivers and coastal waters where the almost universal use of septic tanks and leaching fields has caused serious problems.

In the future special problems occurring as a result of pressures to allow the dumping of exotic type wastes, as well as the end products of secondary and advanced waste treatment processes (sludges, salts, etc.), should be anticipated in the territorial and international waters (including the contiguous zone) adjoining Planning Area No. 5. Alternatives include evaluation of ways to reduce volumes of these waste loads at the source, of alternate methods of disposal. As in the past and as exists presently in other coastal areas of the U.S., pressures will be exerted to allow the alternative of dumping to take place without knowing in advance what effect the act will produce. This is not an alternative and should be legally prohibited.

TREATMENT ALTERNATIVES

A number of methods are available as treatment alternatives. For purposes of this study, however, only secondary and advanced wastewater treatment and regulation, specifically low flow augmentation, have been considered.

Throughout the study period secondary treatment or its equivalent should be required and maintained as the minimum acceptable level of treatment for all biodegradable wastewater discharges in Subregion A. It is recognized, however, that some local areas will require additional measures. Wastes containing other than biodegradable material should receive an equivalent degree of treatment. Effluents containing domestic sewage or pathogenic organisms should be disinfected.

The need for advanced wastewater treatment and low flow augmentation on a broad Planning Area basis was investigated in a preliminary way. The procedure utilized is outlined in detail in Chapter 1. A discussion of this procedure, along with the results of this analysis, is presented above. On this basis a limited combination of advanced wastewater treatment or low flow augmentation will be required in the Planning Areas before 2000. By 2020 advanced wastewater treatment or low flow augmentation will be needed on a general basis in Planning Areas No. 1, 2 and 5, and very probably in 3 and 4. Detailed studies are needed to accurately determine the location of these areas and the most feasible water quality control measures.

In addition to the projected need for advanced wastewater treatment or low flow augmentation, there is a specific need for one or both of these alternatives at Easton in Planning Area No. 1, at Corinna in Planning Area No. 2, and at Winthrop in Planning Area No. 3 at present.

Regionalization, an important concept, deserves serious consideration during the planning, design and construction stages of both secondary and advanced wastewater treatment plants in Subregion A. An economic and water quality analysis for a single wastewater treatment facility to serve several adjoining communities should be a required alternate to a similar analysis of a single wastewater treatment plant for each municipality, whenever federal funds are appropriated for the planning, design or construction of these facilities. Both the single plant and regionalization concept should be analyzed within the framework of a complete river basin or bains.

STUDY NEEDS

Various water quality and pollution study needs for Subregion A have evolved as a result of works on this Appendix. The following tabulation is a list of these study needs.

- 1. Water Resource Council Type II studies or other detailed investigations in each of the Planning Areas.
- 2. Studies to develop optimum "wet process industry" land and water siting plans for each of the Planning Areas.
- 3. Studies to determine existing and potential nutrient problem areas. Consideration should be given to the impact of the highly treated non-industrial and industrial wastes of the future on these areas. In addition, studies to develop ways of removing nitrates and phosphates from these wastes are also needed.

- 4. Studies of existing federal and state water quality laws and cost sharing procedures as they apply to the problems in Subregion A.
- 5. Studies to develop regional solutions to water resource and water quality problems within a river basin framework.
- 6. Studies to determine the best methods of temporarily disposing of wastewater treatment plant sludges and exotic wastes in <u>international</u> waters, and which sea areas adjacent to Planning Areas No. 6, 8, 9 and 10 are best suited for temporary disposal.
- 7. Studies to find the best alternatives for the "ultimate disposal" of wastewater treatment plant sludges and exotic wastes.
- 8. Studies of existing laws that apply to water rights, water use and water needs. Many existing water right laws presently give almost unilateral control of flows to industries in Subregion A.
- 9. Studies to determine the professional and technical manpower needs to plan, design, construct, operate and maintain the wastewater treatment plants and water quality management program in Subregion A.
- 10. Land use and water use studies to determine the costs and benefits of raising or enhancing water quality standards.
- 11. Studies to define and assess the location and magnitude of combined sewer, septic tank and cesspool, thermal, rural and urban runoff, and construction related water quality problem areas, and to define feasible alternates to control these types of pollution.

OTHER NEEDS

- 1. <u>Legal</u>: The following legal needs are considered essential in Subregion A:
- a. Legislation revising the water quality standards of the State of Maine. The Secretary of the Interior has accepted these proposed standards as Federal standards with certain exceptions. The exceptions should be resolved and be incorporated into the water quality standards of the State of Maine. This will enable the Administration of the Environmental Protection Agency to accept these proposed standards as Federal standards in their entirety.
- b. Enforcement of the water quality standards. This is especially critical in regard to maintaining established implementation schedules of wastewater treatment plant construction.
- c. Legislation requiring the mandatory certification of wastewater treatment plant operators.

- d. Legislation which will prevent the discharge of sludges and exotic wastes in the coastal or international waters (including the contiguous zone) adjoining Subregion A by federal, state or municipal governments or private industries operating in the United States.
- e. Legislation to regulate land use, especially lands adjoining the rivers, lakes, ponds and coastal waters of Subregion A.
- f. Legislation to regulate and reduce the use of subsurface disposal systems in Subregion A.
 - g. Legislation adopting a Boat Pollution Control Law.
- 2. Manpower: A recent study by FWPCA has found that at present there are 65 non-industrial wastewater treatment plant operators on duty in the State of Maine. By 1977 an additional 400 non-industrial operators will be required. Figures for industrial wastewater treatment plant operators are not available. Additional trained personnel are also essential for administration of state and regional water quality management programs, for surveillance and enforcement, and to carry on planning functions. Recruiting programs, training programs and personnel position and pay classification reforms should receive serious consideration to meet expanding manpower requirements.
- 3. Research and Development: Important research and development needs in Subregion A are as follows:
- a. Methods of producing paper, textiles and food products economically which do not (1) require the use of large quantities of water and (2) which do not generate large quantities of untreated waste loads. This research and development need should go beyond the examination of existing in-plant manufacturing techniques in these "wet process" industries to the development of entirely new methods which are aimed at changing these industries to "dry process" types. This need calls for a technological change, not in the method of wastewater treatment, but rather in the historic methods of manufacturing paper and processing textile and food products.
- b. Developments or refinements in the present manufacturing methods of paper, textile and food industries (1) which will reduce the generation of the present large quantities of untreated waste, and (2) which will not require the use of the large quantities of water.
- c. Methods of wastewater treatment which in combination with the developments suggested in b. above will bring about the almost

^{1.} Manpower Needs at Water Pollution Control Facilities in New England - FWPCA, June 1969.

complete reuse of water during the industrial process associated with the manufacture of pulp and paper, textiles and food products.

- d. Economical electrical generation methods which do not require large quantities of cooling water. For example, full scale magnetohydynamic (MHD) facilities should be developed without delay.
- e. An economical way of collecting, transporting or treating waste loads in unsewered urban and rural areas. This is especially significant in lake front and coastal water development areas.

Technological advances in the above areas aimed at reducing the amounts of untreated waste load generated will do the most over the study period to upgrade and enhance the waters of Subregion A.

- 4. Public Support: In the final analysis, the people of Subregion A will decide through democratic processes what use is to be made of the water resources of this part of the study area. Whether or not the decision they reach is in the best interest of the majority of the residents depends on how well they and their leaders are informed of the facts concerning their environment and the consequences of their decision or indecision. In studies like the NARS every effort should be made to keep the public and their elected representatives informed, to stimulate their interest, and to enlist their support for water resource planning and development at the start and throughout the study. An example of what this type of support can do when the public and their leaders are involved and active is evidenced in the passage in October 1969 of a bond issue in the State of Maine to provide \$150 million dollars for the construction of pollution abatement facilities.
- Financial: Estimates of the financial investment required for water quality control in Subregion A have been prepared for the design years 1980, 2000 and 2020, and are presented in Table L-9(A). The figures represent the capital investment that would be needed to build wastewater treatment plants capable of treating projected waste loads for each of these target years for secondary wastewater treatment, advanced wastewater treatment, and for combined sewer overflow In practice wastewater treatment facilities are sized to accommodate the projected growth in waste loads over a 20 to 25 year economic plant life. This, plus the actual timing of plant construction, the rate of physical obsolescence and salvage values, will determine actual expenditures over the study period. Operating and maintenance costs for these facilities, as well as expenditures needed for the construction of collection systems and the ultimate disposal of sludge, is also not included. The figures, therefore, serve only to indicate the order of magnitude of financial investment in wastewater treatment plants needed in Subregion A for water quality control and to serve as a common basis of comparison with other Subregions. They are not intended to set or replace estimates developed as the result of detailed engineering studies for specific

TABLE L-9(A)

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL^a/

SUBREGION A

	Estimated	Estimated Addi-	
	Cost of	tional Cost of	
		Advanced Waste	<i>a.l.</i>
Year	Secondary Treatment	Treatment <u>c</u> /	Other Cost d/
	11Catment		
Planning			
Area No. 1			
7000	46 000 000		8,000,000
1980	46,000,000	(53,000,000)	• , ,
2000	98,000,000	101,000,000	•
2020	184,000,000	101,000,000	
Planning			
Area No. 2			
Alea No. 2			
1980	59,000,000		18,000,000
2000	136,000,000	(90,000,000)	
	265,000,000	177,000,000	
2020	203,000,000	177,000,000	
Planning			
Area No. 3			
11100 1.01 0			
1980	38,000,000		21,000,000
2000	61,000,000	(28,000,000)	
	102,000,000	47,000,000	
2020	102,000,000	47,000,000	

TABLE L-9(A) $\mbox{PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL} \mbox{\underline{a}} / \\ \mbox{SUBREGION A}$

Year	Estimated Cost of Secondary Treatment ^b /	Estimated Addi- tional Cost of Advanced Waste Treatment ^c /	Other Cost <u>d</u> /
Planning	, , ,		
Area No. 4 1980 2000 2020	40,000,000 64,000,000 108,000,000	(43,000,000) 72,000,000	18,000,000
Planning Area No. 5			
1980 2000 2020	61,000,000 118,000,000 223,000,000	(25,000,000) 48,000,000	11,000,000

TABLE L-9(A) $\label{eq:projected capital costs of water quality control a}$ $\label{eq:subregion a} \text{SUBREGION A}$

Year	Estimated Cost of Secondary Treatment	Estimated Addi- tional Cost of Advanced Waste Treatment ^c /	Other Cost_
Subregion Tota	11		
1980 2000	224,000,000 477,000,000	(239,000,000)	76,000,000
2020	882,000,000 1,603,000,000	445,000,000 684,000,000	76,000,000

- a./ For general purpose planning only. Based on 1960 dollars. Costs not to be applied to any individual situation.
- b./ Based on treating organic waste loads of both industrial and domestic origin. Treatment is considered to be 85% removal for the year 1980 and 90% for the years 2000 and 2020.
- c./ Treatment which would remove, in addition to 95% Biochemical Oxygen Demand and 98% suspended solids, up to 98% of nutrients and up to 95% of other materials not removed by conventional treatment methods. () Although AWT is not expected to be used throughout in 2000 costs are figured and presented here on this basis. Detailed studies are needed to refine these estimates.
- d./ These costs are where known, estimates for combined sewer overflows control.

municipalities or industries.

Cost estimates for secondary wastewater treatment in Subregion A were determined by developing an average cost per population equivalent to provide this type of wastewater treatment in each planning Area, and applying this figure to the untreated waste loads of the planning area. The average cost per PE varies for each planning area and each target year during the study period. The figures were developed from an analysis of similar costs prepared in a recent study of pollution control needs in the State of Maine. This study considered all known pollution sources individually and developed the costs of providing secondary wastewater treatment for these sources, by utilizing consulting engineering, state classification and state agency reports and generalized wastewater treatment plant cost curves. result, the average cost developed for use in this appendix is considered to reflect the numbers and sizes of the wastewater treatment plants needed in each planning area. This analysis produced average secondary wastewater treatment costs per PE for each planning area that ranged from \$8 to \$28 in 1980, and from \$9 to \$28 in 2000 and 2020. These figures are low when compared with similar figures developed for Subregion B. They reflect the numerous situations in Subregion A where large industrial sources located in small municipalities will be served by one wastewater treatment plant.

Methods used to estimate the cost of advanced wastewater treatment and the control of combined sewer overflows are described in Chapter 1 of this Appendix.

The estimated cost of secondary treatment facilities sized to meet the 1980 waste loads will be on the order of \$244,000,000, \$477,000,000 for the year 2000 loads, and \$882,000,000 for the 2020 projected waste loads.

Although advanced wastewater treatment is not expected to be used on a general basis in Subregion A until the 2000 to 2020 period, costs for this type of wastewater treatment have been estimated for both the 2000 and the 2020 load levels.

Costs to control combined sewer overflows have been figured as a one-time investment by 1980. On a Subregion basis this amounts to \$76,000,000.

^{1.} Report on Immediate Pollution Control Needs New England Rivers Northern Area - FWPCA, June 1967.

VIII. POLLUTION CONTROL PROGRESS

INTERNATIONAL-INTERSTATE

The International Joint Commission (Canada-United States) has been active in the pollution problems of the St. Croix River. Progress reports and supplementary data reports on the St. Croix River are available for the period 1962 through the present. The prestige and influence of this organization has been instrumental in arriving at practical solutions to the problems of the municipalities and the major industries located on the river. Similar efforts by the IJC for other international streams in Subregion A, including the St. John, Aroostook and Meduxnekeag Rivers and Prestile Stream would also be valuable.

Interstate cooperation has existed in the Subregion since 1955 when Maine became a member of the New England Interstate Water Pollution Control Commission. Shortly after Maine joined the commission, water quality standards for interstate streams were established.

STATE

The people of Maine, through the Maine Environmental Improvement Commission, have been active and interested in improving the water quality in the streams of Maine.

Stream classification was initiated in 1953 by the Commission and the upgrading of these waters has been in progress since 1955. A major accomplishment by this organization and the state legislature was the establishment of water quality standards for all of the waters in Maine. These standards were approved by the Secretary of the Interior.

The Maine Environmental Commission has also been instrumental in establishing a state grant-in-aid program which provides 30 percent of the estimated construction cost to local governments.

FEDERAL

Between 1964 and 1968 the Federal Water Pollution Control Administration has participated in projects in the State of Maine that had a total eligible cost of almost \$26,000,000. Federal Water Pollution Control Administration grants amounted to almost \$8,000,000 toward these projects.

In addition water quality studies have been made in the Androscoggin and St. Croix Basins; in the navigable waters of the Penobscot River and Upper Penobscot Bay; and in Lake Sebasticook. The data

collected for the Androscoggin and Penobscot was the basis for FWPCA calling enforcement conferences on these rivers in 1962-1963 and 1967, respectively. During the fall of 1969, FWPCA reconvened an additional session of the Androscoggin River conference.

FWPCA has also participated in a research grant in Subregion A. This grant for \$196,000 was for research on the treatment of potato and sugar beet wastes.

PRIVATE

Private action has been taken by industries and local groups in Subregion A. Several of the paper mills within the Subregion have changed plant operations and processes to reduce waste loads discharged to the rivers.

During 1968, the greatest private action occurred along the Penobscot River in Planning Area No. 2. A paper and pulp mill, the largest single source of waste in Subregion A, announced plans to shift from a sulfite to a magnesium base pulping operation with the recovery of cooking liquors. This mill is located in the upstream reaches of the river and, therefore, this reduction of waste will benefit all downstream water users. In addition, a sulfite pulp and paper mill and a Kraft pulp and paper mill in the lower reaches of the Penobscot have recently closed.

IX. CONCLUSION

The water quality problems found in Subregion A are generally typical of those found in the other subregions of the North Atlantic Region. The Subregion is, however, distinguished from most other Subregions by certain geographic factors, the most notable of which is a relative abundance of water and land resources in relation to its population. This has led to certain types of economic development and caused some pollution problems to be more promiment than others. The most important of these are discussed below:

The first such problem concerns the danger of losing valuable recreation water areas to growing social and economic pressures. For both inland and coastal waters, there is an urgent need to protect high quality water from wastes imposed by local population centers, and from degradation by the recreators themselves. The sharply increasing trend in vacation homes and transient recreation make this task more difficult, but at the same time all the more vital.

Special emphasis on ways to channel growth in the proper direction is essential since there is still time to safeguard most of the natural areas throughout the subregion, and a well balanced recreational environment is rapidly becoming a more and more valuable asset.

Measures for planned land use, legal controls to prevent contamination from new and existing waterfront homes and improvements, strict requirements for sewage conveyance and treatment and vessel pollution control should receive strong emphasis in future water resource planning and action throughout Subregion A.

A second problem area concerns the tremendous waste loads discharged to major streams by a relatively small number of paper and pulp industries. Quantitatively, 86% of the total estimated waste load in the Subregion is contributed by twenty-six paper industries. These twenty-six sources represent only 9% of the total of 283 waste sources in the Subregion.

The control of these wastes is obviously of prime interest, not only because of the widespread impact it will have on water quality throughout the Subregion, but also because of the large investment that will be required. Potential savings from a technological breakthrough in this area are a sufficient incentive to mount an unusually ambitious research and development program.

The size of the paper industry waste loads and of the costs to treat them raises special political and financial problems for the Subregion. Industrial wastewater treatment costs are eligible for federal and state construction grants only if the treatment is provided by a municipality. Thus, depending upon the accessibility of a municipal system, an industry may or may not benefit from aid. This can result in severe cost inequities.

Under the present formula, based largely on population for distributing federal construction grants to the states, Maine receives in the neighborhood of 0.6% of the national allocation, or approximately 6 million dollars per year for a national rate of one billion per year. If it is assumed that all facilities will be eligible for 50% federal aid, it would take upwards of thirty years, using all the federal money allocated to Maine, to provide sufficient funds to furnish the federal share of all of the immediate construction requirements of Subregion A only. In addition serious questions of policy are raised when such a large portion of public money is assigned to what is dominantly a private use with uncertain permanence and uncertain ability to make long term legal commitments.

If, on the other hand, it is assumed the government benefit to major industrial wastewater treatment facilities will either be eliminated or reduced, the companies themselves would have to assume more of the burden. While this would affect the price of goods, it would permit a more timely construction program and would also serve as a strong incentive toward a reassessment of the use of company-owned headwater storage impoundments for water quality control, as well as toward major innovative technological improvements.

Close cooperation is, therefore, required between the companies and water quality control agencies to carry out important research and development activities, and to work out a balanced water quality management plan which most efficiently utilizes both natural and economic resources.

Further study of construction grant procedures is also needed in situations where a single industry is the primary beneficiary. If substantial grants are allowed in these cases, additional federal funds and a larger share for Maine of the national grant program must be considered if water quality standards are to be met in the foreseeable future. If stronger private participation is indicated, eligibility requirements should be reviewed and further sharing arrangements studied.

A third pollution control problem which demands special attention is that of the combined sewer systems. It is a country-wide problem and intensive research and development is consequently already being done nationally that undoubtedly will apply to Subregion A. But, irrespective of new technologies which may be developed, specific solutions to the combined sewer problem must be worked out on an individual basis. This involves a detailed investigation of each system to determine its hydraulic characteristics, its waste characteristics, its effect on water quality standards, the impact on affected water and land use, and the feasibility of alternative solutions. To date, because of the complexity and the urgency of other water quality problems, little has been done in Subregion A to gather the necessary basic data to evaluate the seriousness of the problem or take corrective action. In the future it will assume increasing importance and

will demand concerted action to arrive at workable solutions.

The three problems have been emphasized above because they have special significance to Subregion A. This is not to minimize the seriousness of the other water quality problems cited in this appendix. All are important, some perhaps more locally and others on a more general basis. Each, however, requires attention if the subregion is to have a quality of water in its lakes, streams, rivers, estuaries, bays and open ocean that is suitable for the legitimate development and support of all related activities.

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY

APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 3

SUBREGION B

ENVIRONMENTAL PROTECTION AGENCY
WATER PROGRAMS OFFICE
May 1972

I. SUBREGION SUMMARY

- 1. Subregion B includes the states of New Hampshire,
 Massachusetts, Rhode Island and Connecticut and portions of Maine and
 Vermont. Subregion B includes the cities of Boston, Providence, Hartford, and New Haven which together form the northern portion of the
 northeast's urban corrider. Subdivision of the study area has been
 on the basis of five distinct planning areas consisting of counties or
 groupings of counties rather than on the more familiar hydrologic
 basin breakdown. The major river systems covered, however, include
 the Presumpscot, Saco, Piscataqua, Merrimack, Connecticut, Narragansett
 Bay Drainage, Pawcatuck, Thames, Housatonic and the Atlantic Coastal
 Area from Cape Small, Maine to the Connecticut-New York State line.
- 2. In 1960, the total population of Subregion B was 9.5 million. This figure is expected to increase to 18.3 by 2020. Subregion B's population density is expected to reach 650 persons per square mile, contrasted with the 335 reported in 1960. These figures indicate a tremendous demand by people on and for water pollution control facilities.
- 3. Subregion B had the highest ratio of people employed in manufacturing, to total employment, of all NAR Subregions in 1960. Although manufacturing employment was an important contributor to total employment in Subregion B, this will diminish sharply by 2020.
- 4. While Subregion B was an important manufacturing employment location in 1960, the number of persons employed in the six major water using industries (food, textiles, paper, chemicals, petroleum, primary metals) in this part of the NAR was relatively small and will be even smaller by 2020. Although employment in these industries is expected to decline in relation to total employment in the Subregion industrial water pollution will remain a significant water quality management problem in the future.
- 5. Water use within Subregion B includes municipal and industrial water supply, recreation, commercial fishing and navigation, power generation, irrigation and other legitimate uses. All of these uses, however, are hindered or restricted by the pollution that exists in the Subregion's surface waters. Presently municipalities and industries are the largest water users in Subregions B. In 1965 their combined use amounted to 2378 mgd. Estimates indicate that municipal and industrial water requirements will triple by 2020. As a result of the implementation of the water quality standards, a general trend toward increased use or multiple use of the surface waters of Subregion B can be expected.
- 6. Waste sources within Subregion B include non-industrial, industrial, combined sewers, septic tanks and cesspools, thermal, recreational and commercial navigation, rural and urban runoff, ocean

disposal, construction activities and other types. Of the foregoing, non-industrial, industrial and combined sewer overflows are the most significant. One of the serious problems encountered in this study was the lack of easily accessible information concerning waste sources. Basic data such as locations of polluters, types of waste, waste strengths and flows was often non-existent, old or contradictory.

- 7. There are 1,175 known industrial and non-industrial waste sources and systems that presently discharge 10,600,000 PE's of BOD to the waters of Subregion B. Non-industrial waste sources contributed 4.300.000 PE's or 40 percent of the total waste load while industrial sources discharged 6,300,000 PE's or 60 percent of the combined non-industrial and industrial waste discharges. These percentages are in sharp contrast to similar figures of 3 percent for non-industrial and 97 percent for industrial in Subregion A. Of the 6,300,000 PE's of industrial wastewater discharged, 2,500,000 PE's are discharged by industries to the large non-industrial (municipal systems) of the Subregion, while the remaining 3,800,000 PE's are discharged from point sources directly to the surface waters. Planning area No. 9 currently receives the largest combined non-industrial and industrial waste loads in the Subregion. Unless major changes are made in plant processes at the point of origin or shifts in growth patterns, future non-industrial and industrial untreated waste loads will increase to 25,200,000 PE's in 1980, 38,6000,000 in 2000, and 61,300,000 in 2020. With secondary treatment these loads will be reduced to 3,800,000 PE's in 1980, 3,900,000 in 2000, and 6,100,000 in 2020. Industrial waste loads will represent 54 percent of the raw industrial and non-industrial waste load in 1980, 62 percent in 2000 and 70 percent in 2020. In Subregion A, on the other hand, industrial waste loads are expected to be over 95 percent of the total waste load treated and discharged throughout the study period.
- 8. One hundred and sixty known municipalities in Subregion B have combined sewer systems serving approximately 74 percent of the entire sewered population. These systems presently discharge these combined sewer flows to the waters of the Subregion. Neither the present nor future volume nor strength of this waste is known.
- 9. Major water quality problems presently occur throughout the Subregion. These problems occur on a general basis in all of the Planning Areas and to a limited extent in Planning Area No. 6. The major problems are those associated with dissolved oxygen, coliform and nutrients and are caused primarily by the discharge of raw and partially treated non-industrial and industrial wastes. With full implementation of the water quality standards, including secondary treatment, severe water quality problems from non-industrial and industrial waste sources are not expected to occur on a general basis between 1980 and 2000. Local or limited problems which can be severe should be anticipated. Between 2000 and 2020, widespread violations of the existing standards should be expected in Planning Area

- No. 8 if no more than secondary treatment is provided.
- 10. Pollution control alternatives and needs for Subregion B are summarized below. A more detailed summary of these alternatives and needs are included in the body of the report.
 - a. Source control utilizing (1) new or improved process and treatment methods for the pulp and paper, food, textiles, primary metals, and electrical generation industries; (2) land and water use studies to determine the optimum river locations for future "wet process" industries; (3) efficient or entirely new concepts in collection and treatment methods for urban and rural wastes and combined sewer overflows; (4) the regulation of effluent discharges especially in the coastal waters adjacent to Planning Areas No. 6, 8, 9, and 10. These methods of source control all entail a study need, as well as a research and development need.
 - b. Secondary treatment of all biodegradable wastes is required in Subregion B throughout the study period. Residual waste loads discharged to the streams after secondary treatment will be 3,800,000 P.E.'s in 1980, 3,900,000 in 2000, and 6,100,000 in 2020. Wastes containing other than biodegradable material should receive treatment with removal efficiencies similar to secondary. All effluents containing domestic or pathogenic organisms should be disinfected.
 - c. Advanced wastewater treatment or low flow augmentation will not be required on a general basis throughout the Planning Areas until after 2000, except Planning Area No. 9. Presently, however, there is a need for one or both of these alternatives at specific sites in all of the Planning Areas. Additional local needs for these alternatives should be anticipated and studies initiated to define and assess local problem areas. Between 2000 and 2020, however, advanced wastewater treatment or low flow augmentation or both will be required on a widespread basis in Planning Areas No. 8 and 9.
 - d. The following studies are needed in addition to those already mentioned in (a) and (b) above. Studies to determine (1) existing and potential nutrient and thermal problem areas and the best methods of handling these problems; (2) policies on the disposal of all wastes in international waters beyond the territorial limit of the United States (three miles offshore), adjacent to Subregion B; (3) regional solutions to water quality problems; (4) the professional and technical manpower needs in the Subregion; (5) methods of better regulating control of the river flows; (6) the effectiveness of existing federal, state and interstate pollution laws; (7) the best ways of assembling and disseminating pollution data for federal, state and public use. In addition, Type II Water Resource Council Studies or other

detailed studies are needed in each Planning Area.

- e. Legal considerations include resolution of the present exceptions to the proposed standards taken by the Secretary of the Interior, strict enforcement of the standards including adherance to established implementation schedules, boat pollution laws, mandatory certification of water pollution control facility operators, revision of the present construction grant allocation formulas so as to more adequately meet the wastewater treatment plants needs of Subregion B and revisions to the water quality standards to upgrade certain waters. Other legal needs are discussed in detail in the body of the report.
- f. Research and development needs center about finding more effective and economical ways of (1) reducing and treating the pulp and paper, textile, food processing, primary metals, combined sewer and thermal waste loads and (2) collecting and transporting waste loads in urban and rural areas.
- g. Based on present methods and technology, the financial needs to control pollution over the study period in Subregion B are very high in relation to the population served. The cost of providing secondary treatment for the waste loads of the Subregion will approach \$4.8 billion by 2020. Advanced wastewater treatment costs will be \$600,000,000 by 2020. Control of combined sewer overflows is estimated at \$1.6 billion on a one-time investment before 1980. Additional costs will also be required for operation and maintenance of these facilities as well for needed construction of collection systems.

In order to raise the necessary funds over the 60-year study period in a practical and equitable way, there is a major need to examine the Federal, state and local participation requirements and the role which industry should play. Industrial waste loads have been and will continue to be a major reason for the expansion and enlargement of interceptors, pumping stations and wastewater treatment plants in Subregion B. Equitable capital and operating cost sharing by existing as well as future industries using the municipal, intermunicipal and regional systems of Subregion B is essential.

FIGURE B-1

MAP OF

SUBREGION B

LOCATION AND BOUNDARIES

(Located in back of book)

TABLE L-1(B)

SUBREGION B - PLANNING AREAS

Planning Area Number	Grouping of Whole Counties in the Planning Areas	Complete and Partial Major River Basins Within the Planning Area
6	Cumberland, Me. York, Me. Carroll, N.H. Rockingham, N.H. Strafford, N.H.	Presumpscot River, Me.; Saco River, Me. and N.H.; Piscataqua River, N.H. and Me.; and Atlan- tic Coastal Area from Cape Small, Me. to N.H Mass. State Line.
7	Belknap, N.H. Hillsboro, N.H. Merrimack, N.H. Middlesex, Mass. Worcester, Mass.	Merrimack River, N.H. & Mass.
8	Cheshire, N.H. Coos, N.H. Grafton, N.H. Sullivan, N.H. Caledonia, Vt. Essex, Vt. Orange, Vt. Windham, Vt. Windsor, Vt. Franklin, Mass. Hampden, Mass. Hampshire, Mass. Hartford, Conn. Middlesex, Conn.	Connecticut River, Vt., N.H., Mass. and Conn.
9	Barnstable, Mass. Bristol, Mass. Dukes, Mass. Essex, Mass. Nantucket, Mass. Norfolk, Mass. Plymouth, Mass. Suffolk, Mass. Bristol, R.I. Kent, R.I. Newport, R.I. Providence, R.I. Washington, R.I.	Narragansett Bay Drainage, Mass. and R.I.; Pawcatuck River, R.I., and Conn., and Atlantic Coastal Area from N.HMass. State Line to R.IConn. State Line.

TABLE L-1(B) Cont'd SUBREGION B - PLANNING AREAS

Planning Area Number	Grouping of Whole Counties in the Planning Areas	Complete and Partial Major River Basins Within the Planning Area
10	Berkshire, Mass. Fairfield, Conn. Litchfield, Conn. New Haven, Conn. New London, Conn. Tolland, Conn. Windham, Conn.	Thames River, Conn., Mass. and R.I., Housatonic River, Conn., Mass. and N.Y.; and Conn. Coastal Area.

TABLE L-2(B)

SUBREGION B - MAJOR RIVERS AND TRIBUTARIES

River	Length (Niles)	Drainage Area (Square Miles)
PRESUMPSCOT, SACO and PISCATAQUA RIVER BASINS and ATLANTIC COASTAL AREA from CAPE SMALL, ME. to N.HMASS. STATE LINE		
Presumpscot River Basin		
Presumpscot River	24	648
Saco River Basin		
Saco River	124	1,697
Ossipee River	18	455
Little Ossipee River	31	187
Piscataqua River Basin		
Piscataqua River	13	1,022
Salmon Falls River	21	330
Lamprey River	42	211
Cocheo River	34	182
MERRIMACK RIVER BASIN		
Merrimack	116	5,010 <u>a</u> /
Pemigewasset	64	
Winnipesaukee	23	1,021 486
Contocook	66	766
Piscataquog	33	214
Nashua	34	516
Concord	16	395
CONNECTICUT RIVER BASIN		
Connecticut	280	11,265
Passumpsic	23	507
Ammonosuc	56	402
White	58	712
West	53	423
Ashuelot	60	421
Millers	45	392
Deerfield	73	664
Chicopee	17	721
Westfield	57	517
Farmington	47	602
Black River	40	202
Ottauquechee	38	223

a/ Includes 114 square miles of Canadian drainage.

TABLE L-2(B) Cont'd

SUBREGION B - MAJOR RIVERS AND TRIBUTARIES

River	Length (Miles)	Drainage Area (Square Miles)
NARRAGANSETT BAY DRAINAGE PAWCATUCK RIVER BASIN and ATLANTIC COASTAL AREA from		
N.HMASS. STATE LINE to R.ICONN. STATE LINE		
Narrangansett Bay Drainage		
Taunton	36	543
Blackstone	49	540
Pawtuxet	11	230
Pawcatuck River Basin		
Pawcatuck	22	303
Atlantic Coastal Area		
from N.HMass. State Line		
to R.IConn. State Line		
Charles	65	299
THAMES and HOUSATONIC RIVER BASINS and CONN. COASTAL AREA		
Thames River Basin		
Thames	51	1,474
Shetucket	20	1,263
Quinebaug	76	744
Housatonic River Basin		
Housatonic	131	1,950
Naugatuck	41	311
Ten Mile	15	210
Shepaug	34	158
Conn. Coastal Area		
Quinnipiac River	45	164

II. DESCRIPTION OF SUBREGION

LOCATION AND BOUNDARIES

Subregion B is located in the northeastern part of the North Atlantic Regional Water Resource Study Area and includes all of New Hampshire, Massachusetts, Rhode Island and Connecticut, the counties of York and Cumberland in Maine, and the five easterly counties of Vermont (Caledonia, Essex, Orange, Windham, and Windsor). The geographical boundaries of Subregion B are shown in Figure B-1. This Subregion encompasses nearly half of New England 29639 square miles, and includes 1502 square miles of inland surface waters and 1850 miles of coastline.

Subregion B was divided by the Coordinating Committee into five water resource planning areas delineated by county boundaries, each planning area consists of one or more whole counties. Table L-1(B) lists the areas, the counties, and the whole or partial river basins in each planning area.

PHYSICAL FEATURES

- General Hydrology: The major river systems in Subregion B are the Presumpscot, Saco, Piscataqua, Merrimack, Connecticut, the New Hampshire reach of the Androscoggin, the Narragansett Bay Drainage Area, and the Atlantic Coastal Area from Cape Small, Maine to the Connecticut-New York State line. The location of these river systems are shown in Figure B-1. These rivers have a drainage area of approximately 44,200 square miles. Many of the rivers in Subregion B have extensive upstream storage impoundments which are regulated by private interests for hydroelectric and industrial process and cooling water purposes. This regulation substantially augments natural river flows during summer and fall seasons with some beneficial effect on water quality. Selected hydrologic information consisting of lengths and drainage areas for the major rivers and tributaries within Subregion B is presented in Table L-2(B). Detailed hydrologic data for these rivers are presented in Appendix C - Climate, Meteorology and Hydrology of the NAR Report.
- 2. General Geology: Subregion B has a long and varied coastline marked by numerous coastal rivers, estuaries, bays, rocky headlands and sandy beaches. The most prominent coastline features are Cape Ann, Cape Cod and Narragansett Bay.

Lowlands extend from the coast only a short distance into each Planning Area. The remainder of the Subregion is upland which is generally higher and more rugged in the central and northern portions of Planning Areas No. 6, 7, 8, and 10. The White Mountains topped by 6,288 feet Mt. Washington serves as the easterly divide of Subregion B. The Green Mountains and the Berkshire Hills form the western

divide. Much of the terrain and many of the streams in Subregion B are suitable for impoundments.

The overburden of Subregion B consists mainly of glacial till. This unsorted material has been covered in many areas by glacial outwash and such landforms as kames, kame terraces, deltas and eskers. Specific information on the geology of Subregion B is given in Appendix D - Geology and Groundwater of the NAR Report.

CLIMATE

According to information presented in Appendix C - Climate, Meteorology and Hydrology of the NAR Report, Subregion B has four distinct seasonal variations that cause temperature fluctuations in the average year of over 50°F in the north and about 41°F along the coast. Temperatures in the summer months are moderate. Average July temperatures along the coast are 72°F and 62°F in the extreme north. January temperatures average 30°F along the coast and about 11°F in the extreme north.

Precipitation in the Subregion is well distributed throughout the year. Most of Subregion B receives 35" to 46" of rain annually, with substantially larger amounts in the mountains. Winter precipitation is in the form of snow which averages 34" to 168" from south to north.

TABLE L-5(B)

SUBREGION B - ESTIMATED PRESENT NON-INDUSTRIAL DISCHARGES*

		D E	GRE	E 0	F TRE	ATME		Systems	Systems	Combined
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated	Not Chlor- inating	Sewer Systems
6										
Number of Systems	80		47	20		13			67	24
Pop. Served (000)	265		139	65		61			205	189
Waste Load Disch.										
Calc. P.E. (000)	190		139	42		9				
7										
Number of Systems	102	1	58	10	1	31	1		89	38
Pop. Served (000)	721		293	68	1	356	3		666	511
Waste Load Disch.										
Calc. P.E. (000)	391		293	44		54				
8										
Number of Systems	152	1	92	47		12			118	66
Pop. Served (000)	1,257		189	996		72			1,050	983
Waste Load Disch.										
Calc. P.E. (000)	849		189	649		11				
9										
Number of Systems	151		69	30		50	2 3		100	14
Pop. Served (000) Waste Load Disch.	3,591		525	2,471		592	3		656	3,015
Calc. P.E. (000)	2,220		525	1,606		89				

^{*}Includes waste loads from municipalities, institutions and Federal installations.

TABLE L-5(B) Cont'd

SUBREGION B - ESTIMATED PRESENT NON-INDUSTRIAL DISCHARGES*

		DEGREE OF TREATMENT						Systems	Systems	Combined
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated	Not Chlor- inating	Storm- Sewer Systems
10										
Number of Systems	102		29	42		31			44	18
Pop. Served (000)	1,184		75	789		320			241	495
Waste Load Disch. Calc. P.E. (000)	634		75	511		48				
Subregion Total					_		•		/10	160
Number of Systems	587	2	295	149	1	137	3		418	160
Pop. Served (000) Waste Load Disch.	7,018		L,221	4,389	1	1,401	6		2,826	5,193
Calc. P.E. (000)	4,284		L,221	2,852		211				

^{*}Includes waste loads from municipalities, institutions and Federal installations.

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TABLE L-6(B)

SUBREGION B - ESTIMATED PRESENT INDUSTRIAL WASTES

SUMMARY

2 Digit SIC Gro	Waste Load Before Treat. up (Est. P.E.)	Number of Known Sources	W None	ADE (ASTE Partial	U A C Y T R E A T Complete	O F M E N T Unknown	Discharged Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
20 Food Water Use M	237,000	52	40	6	1	5	216,000	SS ¹ /, Grease, Oil, Disease-Bacteria
22 Textiles Water Use M	878,000 GD	180	156	23	1		761,000	SS, Color
26 Paper Water Use M	2,741,000 GD	109	68	39	2		2,686,000	SS, Color, pH
28 Chemicals Water Use M	109,000 GD	59	34	21	2	2	105,000	SS, Color, Oil, pH, Grease, Toxic Materials
29 Petroleum Water Use M	GD	4			1	3		SS, Oil, Grease
33 Primary Meta Water Use M		184	155	22	2	5	62 .000	Toxic Metals,pH, SS, Oil
xx Other Indus Groups	3,410,000						2,478,000	
Subregion Total Water Use Mo		588	453	111	9	15	6,308,000	

^{1/} SS - Suspended solids.

TABLE L-6(B)

SUBREGION B - ESTIMATED PRESENT INDUSTRIAL WASTES

	2 D	igit SIC Group	Waste Load Before Treat. (Est. P.E.)	Number of Known Sources	W None	ADE (ASTE Partial	UACY TREAT	O F M E N T Unknown	Discharged Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
	20	Food Water Use MGD	10,000	3	3				10,000	SS ^{1/} , Grease, Oil, Disease-Bacteria
	22	Textiles Water Use MGD	103,000	10	10				81,000	SS, Color
L-164	26	Paper Water Use MGD	348,000	7	3	4			347,000	SS, Color, pH
4	28	Chemicals Water Use MGD								SS, Color, pH, Oil, Grease, Toxic Material
	29	Petroleum Water Use MGD								SS, Oil, Grease
	33	Primary Metals Water Use MGD								Toxic Metals, pH SS, Oil
	xx	Other Indus. Groups	133,000						133,000	
	Sub	region Total Water Use MGD	594,000	20	16	4			571,000	

^{1/} SS - Suspended solids.

TABLE L-6(B)

SUBREGION B - ESTIMATED PRESENT INDUSTRIAL WASTES

PLANNING AREA NO. 7

-	2 D	igit SIC Group	Waste Load Before Treat. (Est. P.E.)	Number of Known Sources	W None	ADEQ ASTE Partial	U A C Y T R E A T Complete	O F M E N T Unknown	Discharged Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
_	20	Food Water Use MGD	63,000	6	4			2	63,000	SS ^{1/} , Grease, Oil, Disease-Bacteria
	22	Textiles Water Use MGD	263,000	56	50	6			254,000	SS, Color
L-165	26	Paper Water Use MGD	188,000	17	10	7			172,000	SS, Color, pH
	28	Chemicals Water Use MGD	30,000	10	7	3			29,000	SS, Color, pH, Oil, Grease, Toxic Material
,	29	Petroleum Water Use MGD		4			1	3		SS, Oil, Grease
	33	Primary Metals Water Use MGD	45,000	15	13	1	1		40,000	Toxic Metals, pH SS, Oil
	xx	Other Indus. Groups	174,000						96,000	
-	Sub	region Total Water Use MGD	763,000	108	84	17	2	5	654,000	

^{1/} SS - Suspended solids.

TABLE L-6(B)

SUBREGION B - ESTIMATED PRESENT INDUSTRIAL WASTES

	2 D	rigit SIC Group	Waste Load Before Treat. (Est. P.E.)	Number of Known Sources	W M	ADEQ ASTE Partial	UACY OF TREATMENT Complete Unknown	Discharged Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
	20	Food Water Use MGD	139,000	21	20	1		120,000	SS ^{1/} , Grease, Oil, Disease-Bacteria
	22	Textiles Water Use MGD	146,000	25	23	2		145,000	SS, Color
-	26	Paper Water Use MGD	1,931,000	56	43	13		1,924,000	SS, Color, pH
6	28	Chemicals Water Use MGD	56,000	7	3	3	1	53,000	SS, Color, pH, Oil, Grease, Toxic Material
	29	Petroleum Water Use MGD							SS, Oil, Grease
	33	Primary Metals Water Use MGD	20,000	31	26	5		10,000	Toxic Metals, pH SS, Oil
	xx	Other Indus. Groups	179,000					129,000	•
	Sub	region Total Water Use MGD	2,471,000	140	115	24	1	2,381,000	

 $[\]underline{1}$ / SS - Suspended solids.

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TABLE L-6(B)

SUBREGION B - ESTIMATED PRESENT INDUSTRIAL WASTES

2 Digit S	SIC Group	Waste Load Before Treat. (Est. P.E.)	Number of Known Sources	W None	ADE(ASTE Partial	U A C Y T R E A T Complete	OF MENT Unknown	Discharged Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
20 Food	Use MGD	1,000	5	1	3	1	Olikilowii	1,000	SS ¹ /, Grease, Oil, Disease-Bacteria
22 Texti Water	les Use MGD	354,000	45	32	12	1		269,000	SS, Color
26 Paper Water	Use MGD	150,000	10	2	7	1		130,000	SS, Color, pH
28 Chemi Water	cals Use MGD	23,000	13	7	4	1	1	23,000	SS, Color, pH, Oil, Grease, Toxic Material
29 Petro Water	leum Use MGD								SS, Oil, Grease
	ry Metals Use MGD	11,000	42	39	3			11,000	Toxic Metals, pH SS, Oil
xx Other Gro	Indus.	2,835,000						2,092,000	
Subregion Water	Total Use MGD	3,374,000	115	81	29	4	1	2,526,000	

 $[\]underline{1}$ / SS - Suspended solids.

TABLE L-6(B)

SUBREGION B - ESTIMATED PRESENT INDUSTRIAL WASTES

PLANNING AREA NO. 10

2 Digit SIC Gro	Waste Load Before Treat oup (Est. P.E.)	Number of Known Sources	W None	ADEO ASTE Partial	U A C Y T R E A T Complete	O F M E N T Unknown	Discharged Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
20 Food Water Use 1	24,000	17	12	2		3	22,000	SS ¹ /, Grease, Oil, Disease-Bacteria
22 Textiles Water Use N	12,000 4GD	44	41	3			12,000	SS, Color
26 Paper Water Use 1	124,000	19	10	8	1		113,000	SS, Color, pH
28 Chemicals Water Use I	4GD	29	17	11		1		SS, Color, pH, Oil, Grease, Toxíc Material
29 Petroleum Water Use	MGD							SS, Oil, Grease
33 Primary Me Water Use		96	77	13	1	5	1,000	Toxic Metals, pH SS, Oil
xx Other Indu	89,000						28,000	
Subregion Tota Water Use		205	15 <i>7</i>	37	2	9	176,000	

 $[\]underline{1}$ / SS - Suspended solids.

TABLE L-7(B)SUBREGION B - PRESENT AND FUTURE ORGANIC WASTE LOADS

SUMMARY

Industrial,

Total

Year	Waste Load, <u>a</u> / (P.E.) 000		Waste Load, b/ (P.E.) 000		Waste Load, (P.E.) 000	
	Before Treatment	After Treatment <u>c</u> /	Before Treatment	After Treatment	Before Treatment	After Treatment <u>c</u> /
1960	9,550 <u>d</u> /	4,284	7,453	6,308	17,003	10,952
1980	11,778	1,768	13,381	2,007	25,169	3,775
2000	14,791	1,479	23,779	2,378	38,570	3,857
2020	18,397	1,840	42,887	4,289	61,284	6,128

Non-Industrial

Includes waste loads from municipalities, institutions and Federal Installations.

Includes the waste loads from the six major water-using two digit SIC groups.

Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.

Includes 2,532,000 persons not served by non-industrial waste collection systems.

TABLE L-7(B)

SUBREGION B - PRESENT AND FUTURE ORGANIC WASTE LOADS

Industrial,

Waste Load, D

Total

Waste Load,

(P.E.) 000 (P.E.) 000 (P.E.) 000 After Before After Before After Before Treatment c/ Treatment C/ Treatment C Treatment Treatment Year Treatment 457<u>d</u>/ 1960 190 594 571 051 761 1980 580 87 1,039 1,619 243 156 2,426 243 734 73 1,692 169 2000 917 92 2,812 281 3,729 373 2020

Non-Industrial

Waste Load, a

a/ Includes waste loads from municipalities, institutions and Federal Installations.

b/ Includes the waste loads from the six major water-using two digit SIC groups.

c/ Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.

d/ Includes 192,000 persons not served by non-industrial waste collection systems.

TABLE L-7(B)

SUBREGION B - PRESENT AND FUTURE ORGANIC WASTE LOADS

Industrial Waste Load, b/

Total Waste Load,

	(P.E.) 000		(P.E.) 000		(P.E.) 000	
<u>Year</u>	Before Treatment	After Treatment ^c /	Before Treatment	After Treatment c/	Before Treatment	After Treatment ^c /
1960	1,230 <u>d</u> /	391	763	654	1,993	1,045
1980	1,438	216	1,331	200	2,769	415
2000	1,860	186	2,468	247	4,328	433
2020	2,192	219	4,368	437	6,560	656

Non-Industrial Waste Load, a

 $[{]f a}/$ Includes waste loads from municipalities, institutions and Federal Installations.

b/ Includes the waste loads from the six major water-using two digit SIC groups.

c/ Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.

 $[\]underline{d}$ / Includes 509,000 persons not served by non-industrial waste collection system.

TABLE L-7(B) SUBREGION B - PRESENT AND FUTURE ORGANIC WASTE LOADS

	Non-Industrial Waste Load, <u>a</u> / (P.E.) 000		Industrial _b / Waste Load, <u>b</u> / (P.E.) 000		Total Waste Load, (P.E.) 000	
<u>Year</u>	Before Treatment	After Treatment ^c /	Before Treatment	After Treatment	Before Treatment	After Treatment
1960	1,636 <u>d</u> /	849	2,471	2,381	4,107	3,230
1980	1,908	286	4,796	719	6,704	1,006
2000	2,320	232	8,986	899	11,306	1,131
2020	3,089	309	17,259	1,726	20,348	2,035

- Includes waste loads from municipalities, institutions and Federal Installations.
- Includes the waste loads from the six major water-using two digit SIC groups.
- Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.
- Includes 2,532,000 persons not served by non-industrial waste collection system.

TABLE L-7(B)

SUBREGION B - PRESENT AND FUTURE ORGANIC WASTE LOADS

Industrial,

Waste Load, -

Total

Waste Load,

(P.E.) 000 (P.E.) 000 (P.E.) 000 Before After Before After Before After Treatment Treatment Year Treatmen Treatment Treatment Treatment 4,324<u>d</u>/ 1960 2,220 3,374 2,526 7,698 4,746 1980 5,311 797 5,708 856 11,019 1,653 6,517 652 970 16,214 2000 9,697 1,621 2020 8,094 809 16,730 1,673 24,824 2,482

- a/ Includes waste loads from municipalities, institutions and Federal Installations.
- b/ Includes the waste loads from the six major water-using two digit SIC groups.

Non-Industrial

Waste Load, a

- c/ Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.
- d/ Includes 733,000 persons not served by non-industrial waste collection system.

TABLE L-7(B) SUBREGION B - PRESENT AND FUTURE ORGANIC WASTE LOADS

	Non-Industrial Waste Load, <u>a</u> / (P.E.) 000		Industrial _b / Waste Load, <u>b</u> / (P.E.) 000		Total Waste Load, (P.E.) 000	
<u>Year</u>	Before <u>Treatment</u>	After <u>Treatment</u> c/	Before <u>Treatment</u>	After <u>Treatment</u> c/	Before <u>Treatment</u>	After <u>Treatment</u>
1960	1,903 <u>d</u> /	634	251	176	2,154	810
1980	2,551	383	507	76	3,058	459
2000	3,360	336	936	94	4,296	430
2020	4,105	410	1,718	172	5,823	582

- Includes waste loads from municipalities, institutions and Federal Installations.
- Includes the waste loads from the six major water-using two digit SIC groups.
- Present treatment practices for 1960, secondary treatment for 1980, 2000, 2020.
- Includes 719,000 persons not served by non-industrial waste collection system.

used to account for all industrial sources discharging to these systems. This grouping could include wasteloads from the six major water using industries that discharge to municipal systems but do not include the previous mentioned point sources.

Of the point sources composed of the six major water using industries, the manufacturing, and processing operations of the food, textile and paper industries contribute significant quantities of oxygen demanding wastes loads to the surface waters of Subregion B. As a single source paper manufacturing wastes exerted the greatest oxygen demand on the waters of Subregion B. This industry discharged at least 2,700,000 P.E.'s to these waters. Within the Subregion, pulp and paper waste loads were the heaviest in Planning Area No. 8. Of the 1,100,000 P.E.'s discharged by the remaining six major water users, at least 800,000 P.E.'s were contributed by the textile industry.

Other Industrial Groups, defined above, discharged 2,500,000 P.E.'s of the total industrial waste load. At least 2,100,000 P.E.'s or 84 percent of this type of waste load was discharged in Planning Area No. 9. This value reflects the relatively large but unknown number of industries which presently discharge to the regional and municipal systems of this heavily urbanized Planning Area.

The primary metals industry (SIC 33) is a significant source of pollution in Planning Area No. 6, 8, 9, and 10 although this type of waste doesn't exert a large biochemical oxygen demand when compared with the other six major water using industries. Specific information is lacking, however, one hundred and eighty-four sources discharge wastes that could be toxic.

Of the 588 sources of industrial wastes in Table L-6(B), 453 did not provide any treatment, only 111 offered partial treatment of all wastes, and only 9 provided secondary treatment.

Based on industrial activity, untreated industrial waste loads in Subregion B will increase to 13,400,000 P.E.'s in 1980, 23,800,000 in 2000, and 42,900,000 in 2020. These values are summarized in Table L-7(B). Analysis of this information shows that untreated industrial waste loads will increase almost six times during the period 1960-2020. In this regard, Planning Area No. 9 can expect to feel the impact from the largest industrial waste load in the Subregion.

Secondary treatment of future raw industrial waste loads will produce treated effluents of 2,000,000 P.E.'s in 1980, 2,400,000 in 2000, and 4,300,000 in 2020. Fifty-two percent of all waste loads treated in 1980 will be industrial. This percentage will increase to 62 percent by 2000 and 70 percent by 2020. These percentages, though less than those for Subregion A where over 95 percent of all waste loads treated will be industrial, demonstrate that industrial needs will increasingly dominate requirements for treatment plant

construction in Subregion B.

COMBINED SEWER SYSTEMS

Stormwater and municipal wastes are presently collected, transported and discharged through combined sewer systems in 160 known municipalities within Subregion B. These combined sewer systems serve an estimated 5,200,000 people or approximately 74 percent of the entire sewered population presently discharging wastes to the surface waters of Subregion B. The greatest numbers of combined systems occur in Planning Areas No. 6, 7, and 8; however, Planning Area No. 9 has combined sewer systems which service 58 percent of the total people served by combined sewers. Presently, information is not available to estimate the amounts of waste which these systems discharge to the waters of Subregion B.

SEPTIC TANKS AND CESSPOOLS

Within the Subregion there are more than 999,000 separate housing units, as well as an unknown number of business establishments, which dispose of waste through septic tanks or cesspool systems. Because the natural overburden in the Subregion is of glacial origin and a large percentage of the area is covered with impervious soil types, septic tanks and cesspool systems often fail to provide adequate treatment.

Except in the vicinity of the relatively few urban areas and rural communities, sub-surface disposal methods can be expected to increase in numbers throughout the study period. Recreational home developments abutting the fresh water lakes and ponds as well as the coastal waters will be the cause of serious pollution loads in the future. Septic tanks and cesspools are being used to service these developments rather than municipal sewer systems and secondary treatment plants. Specific data concerning the numbers of these future installations is not known.

MINE DRAINAGE

The only known source of mine drainage in Subregion B is from an abandoned copper mine draining to the Ompompanoosuc River at South Strafford, Vermont. This drainage is small and is not expected to increase in the future.

THERMAL SOURCES

Although information concerning the present numbers of thermal sources is not available for the Subregion, approximately 190 billion

gallons of water were utilized by manufacturing concerns for cooling and condensing purposes in Maine during 1963. As of 1966, there were sixty public utility steam generating power plants in Subregion B producing about 7,300,000 KW of electric power.

At present there are two nuclear powered steam electric plants operating in Planning Area No. 8. Yankee Atomic at Rowe, Massachusetts and Connecticut Yankee at Haddam, Connecticut produce 185 MW and 490 MW of electricity, respectively. Yankee Atomic utilizes approximately 120 mgd of water for cooling purposes. Connecticut Yankee requires approximately 455 mgd of cooling water. Both of these facilities cause a 20°F increase in the temperature of the cooling water discharged to adjacent waters.

In addition, there are three nuclear plants presently under construction in Subregion B. These are located in Planning Area No. 8 at Vernon, Vermont, in Planning Area No. 9 at Plymouth, Massachusetts and in Planning Area No. 10 at Millstone Point, Connecticut. These plants will produce 540 MW, 680 MW and 550 MW of electricity, respectively. This heated cooling water will be discharged to the rivers and coastal waters.

Future plans presently anticipate at least four additional nuclear plants for Planning Area No. 9. By 2020, estimates indicate that nuclear fuels will supply the necessary energy for the generation of 75 percent of the electrical power needs in New England.

The total energy generation requirement from thermal plants is estimated to be 27,181~MW in 1980, 81,272~MW in 2000 and 195,900~MW in 2020 for the Subregion.

RECREATIONAL AND COMMERCIAL NAVIGATION

Recreational boats, commercial vessels, and associated shore facilities are all possible sources of pollution of the surface waters of Subregion B, but the magnitude of this problem is unknown.

During 1965, the States of New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut issued registration numbers for at least 187,000 recreational type watercraft. In this Subregion, pollution caused by recreational boating usually occurs on weekends, holidays and vacation periods of the late spring, summer and early fall. These boats usually concentrate in coves, inlets and other areas which are used for water contact sports, thus increasing the health hazards from this type of pollution.

According to Appendix K covering navigation, commercial navigation in Subregion B is extensive. The major ports in the Subregion are Portland, Maine in Planning Area No. 6, Boston, Massachusetts, and Providence, Rhode Island in Planning Area No. 9 and New Haven,

Connecticut in Planning Area No. 10. The principal cargo moved through these ports is oil and oil products. It is significant to note that Portland, Maine is the second largest crude oil port in the United States. The greatest danger from this type of traffic lies in the possibility of a massive oil pollution incident. During 1969, there were 23 major and 45 minor oil spills in the waters of Subregion B that required FWQA involvement. In addition, there were 120 minor violations involving the U. S. Coast Guard only.

Future wastes from recreational and commercial navigations can be expected to increase throughout the study period.

RURAL AND URBAN RUNOFF

Information is not available which accurately portrays the magnitude or types of waste loads that are being discharged to the surface waters of Subregion B by rural and urban runoff. The following information is presented, however, in order that some feeling for these waste loads may be obtained.

During 1959, approximately 170,000 tons of commercial grade fertilizers were spread on 531,000 acres of land in the rural areas of the Subregion. Pesticides are another ingredient of rural runoff. Pesticides are usually prepared and mixed in the fields utilizing water drawn from small farm ponds, brooks, or sump holes. Indiscriminate spillage of sprays and the improper disposal of containers containing pesticides can cause serious pollution problems. Forestry operations in Subregion B contribute soil erosion and some herbicides to the rural runoff in the area.

Urban runoff has become an increasingly important source of pollution that is reaching the surface waters of the Subregion. Data are not available to indicate the magnitude of this waste load but each year additional acres of land are withdrawn from agriculture or other use patterns for urban development. A good portion of these once relatively pervious lands are then covered with impervious material with a resulting high degree of runoff to the surface waters. Urban runoff contains oils, organic matter, trash, soils, fertilizers and whatever else can be easily swept or washed into the street gutter or watercourse. These wastes cause an oxygen demand on the receiving waters.

Both rural and urban runoff will continue to be significant waste sources during the study period.

OCEAN DISPOSAL

The coastal waters of Subregion B (territorial waters of U.S.- 3 miles offshore) receive untreated or partially treated wastes from

municipalities and industries. Until February 1970 the international waters including the contiguous zone (3-12 miles offshore) were being used as a dumping ground for exotic wastes such as radioactive materials, nitric and sulfuric acids, sodium hydroxide, ether, toluene and acetone. This method of disposal has been temporarily suspended and is under study. Excavated overburden and bedrock materials are deposited in these waters.

Pressures for the disposal of wastes in ocean areas, in the future, can be expected to increase throughout the study period. This will be especially true for exotic types as well as for the sludges, solids, and salts from secondary and advanced wastewater facilities.

CONSTRUCTION ACTIVITIES

Earth moving operations associated with the construction of high-ways, airfields, real estate developments, navigation channels, marine terminals, water resource projects including wastewater treatment facilities and agriculture and forestry operations can expose soils which are easily eroded by wind and water. Without careful controls during the life of the construction project serious sedimentation problems can result.

An increase in the number of waste sources associated with construction operations should be anticipated in Subregion B, throughout the study period.

VI. PRESENT AND FUTURE WATER QUALITY PROBLEMS

GENERAL

Major water quality problems occur on many of the rivers of Subregion B. Raw and inadequately treated non-industrial and industrial waste loads are presently the overwhelming cause of these problems. Problems associated with dissolved oxygen and coliform levels, nutrients and sedimentation are all related to the discharge of these non-industrial and industrial wastes. Additional waste loads from combined sewers, septic tanks and other sources add to these problems in varying degrees throughout the Subregion.

Assuming that non-industrial and industrial waste loads receive secondary treatment, widespread water quality problems should not occur until 2000; however, limited problems may be expected throughout the study period due to the discharge of secondary treated non-industrial and industrial waste loads, combined sewer overflows, septic tanks and cesspool effluents, thermal waste loads, oil pollution, problems associated with recreational and commercial navigation, ocean disposal of sludges and exotic wastes.

Information concerning the present and future water quality problems of the Subregion B is presented in detail in the following paragraphs.

NON-INDUSTRIAL AND INDUSTRIAL WASTES

Raw, partially treated and treated waste loads from non-industrial and industrial waste sources amounting to 10,600,000 P.E.'s are presently discharged to the inland and coastal waters of Subregion B. As a result, major reaches of several of the rivers in the Subregion are seriously degraded. Figure B-2 shows the surface waters within the Subregion where non-industrial and industrial waste loads presently cause serious water quality problems. Rivers and surface waters with water quality problems associated with these types of waste loads are tabulated in Table L-8(B).

Water quality problems associated with dissolved oxygen and coliform levels resulting from the discharge of industrial and non-industrial wastes presently occur in Planning Area No. 6 on the Presumpscott below Westbrook, the Saco below Steep Falls, the Mousam below Sanford and the Piscataqua. In Planning Area No. 7 the Merrimack over its entire length, the Souhegan below Wilton, the North Nashua, Nashua Ashuelot and Concord are in a degraded condition. In Planning Area. No. 8, the Connecticut below Groveton and Holyoke and reaches of the Passumpsic, Wells, Ompompanoosac, Mascoma, Millers, Westfield and Chicopee all have significant water quality problems. The portion of the Androscoggin within Planning Area No. 8 is badly degraded in the

FIGURE B-2

MAP OF

SUBREGION B

WATER QUALITY PROBLEM AREAS

(Located in back of book)

TABLE L-8(B)

SUBREGION B - KNOWN WATER POLLUTION PROBLEMS

						Acid		•
	Non-			Septic		Mine		
	$Indus_{1/}$	Indus-	2/	Tanks &	Naviga-	Drain-	4.1	5/
Water Body	trial ¹	trial	Thermal ²	Cesspools	tion3/	age	Runoff4/	0ther <u>5</u> /
			DT 437		_			
			PLAN.	NING AREA NO.				
PRESUMPSCOT, SACO	AND PISCATAC	QUA RIVER BA	SINS AND ATL	ANTIC				
COASTAL AREA FROM								
	-							
PRESUMPSCOT RIVER	BASIN							
Presumpscot	x	x						
SACO RIVER BASIN								
Saco	x	x						
	X	X						ь
Province Lake								U
PISCATAQUA RIVER B.	ASIN							
Salmon Falls	x	x						С
Piscataqua	x							
Cocheco	x	x						
ATLANTIC COASTAL A		PE SMALL, ME	•					
TO N.HMASS. ST.	LINE							
Portland Harbor					x			a
Mousam River	x	x						

TABLE L-8(B) Cont'd

SUBREGION B - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus <u>ī</u> / trial	Indus- trial	Thermal ^{2/}	Septic Tanks & Cesspools	Naviga- tion-	Acid Mine Drain- age	Runoff ^{4/}	Other 5/
				NING AREA NO.	7			
ŒRRIMACK RIVER BASI	N							
Pemigewasset	_	x						
Merrimack	x	x						С
Nashua	x	x						С
N. Nashua	x	x						
Assabet-Concord	x	x						•
Lake Winnipesaukee	2							b
Lake Winnisquam								b h
Kezar Lake								b
Silver Lake								b b
Glen Lake								-
Kelley's Falls Por	ıd							ზ ზ
Millville Lake								ъ
Whitehall Reservoi	ir							Ъ
Lake Boon								Ъ
Lake Quinsiqamond								b
Nuttings Lake	•							Ь
			PLAN	NING AREA NO.	8			
CONNECTICUT RIVER BA								С
Connecticut	x	x						c
Ashuelot	x	х						c
Millers	x	x						c
Chicopee	x	x						c
Ware	x	X						c
Quaboag	X	x						c
Westfield	x	x						Ъ
Mascoma Lake								b
Lake Morey								b
Skatatakee Lake								J

TABLE L-8(B) Cont'd

SUBREGION B - KNOWN WATER POLLUTION PROBLEMS

						· · · · · · · · · · · · · · · · · · ·	<u></u>		
	I	$\frac{1}{1}$	Indus- trial	Thermal ² /	Septic Tanks & Cesspools	Naviga- tion3/	Acid Mine Drain- age	Runoff ^{4/}	Other ⁵ /
					NING AREA NO. 9	İ			
				1 131111	THO MEDIT NO. 7	-			
	NARRAGANSETT BAY DRAIN	AGE AND E	PAWCATUCK R	IVER BASIN					
	ATLANTIC COASTAL AREA	FROM N.H.	-MASS ST. 1	LINE TO R.I	<u>-</u>				
	CONN. ST. LINE NARRAGA	NSETT BAY	Y DRAINAGE						
	Blackstone	x	x		x				
	Chepachet		x						
	Pascoag								С
г	Pawtuxet	x	х						
.–185	Ten Mile	X	x						
5	Taunton Rumford-Threemile	x x	x x						b&c
	Rumford-im eemire	Х	X						Dac
	ATLANTIC COASTAL AREA	FROM N.H.	-MASS. ST.	LINE TO R.I.	. -				
	CONN. ST. LINE								
	North River								Ъ
	Charles River	x	x						b
	Neponset River		x						
	Westport River								b
	Gloucester Harbor	x	x			X .			
	Salem-Beverly Harbor	x	x						b
	Lynn Harbor	x	x						
	Boston Harbor	x	x			x			a&b
	Providence Harbor	X	x			X.			L
	Provincetown Harbor								b b
	Mystic Lakes Norton Reservoir								b b
	MOLCOH Keselvoll								D

TABLE L-8(B)

SUBREGION B - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus <u>ī</u> /	Indus- trial	Thermal $\frac{2}{}$	Septic Tanks & Cesspools	Naviga- tion	Acid Mine Drain- age	Runoff 4/	Other 5/
			PLAN	NING AREA NO.	10			
THAMES AND HOUSATON AND COASTAL AREA	IC RIVER BA	ASINS			·			
THAMES RIVER BASIN								
Quinebaug	x	x						
French	x	x						
Shetucket	x	x						
HOUSATONIC RIVER BA	SIN							
Housatonic	x	x						
Still	\mathbf{x}	x						
Naugatuck	x	x						1_
Onota Lake								b b
Bantam Lake								b
Lillinonah Lake								ь Ъ
Zoar Lake								D
CONN. COASTAL AREA Quinnipiac				•				ь
New Haven Harbor	x	x			x			Ъ

- 1. Includes wastewater from municipalities, institutions, and Federal installations.
- 2. Includes thermal wastes from industry and thermal power plants.
- 3. Includes all types of waste from commercial, recreational and Federal navigation.
- 4. Wastewater containing: (a) agricultural chemicals; and (b) sediment from agricultural and urbanization or industrial operations.
- 5. a. combined sewer systems
 - b. nutrient enriched water
 - c. inadequate dilution
 - d. suspect

reach from Berlin, New Hampshire, to the Maine-New Hampshire border. The Charles, Neponset, Ten Mile, Taunton, Blackstone and Pawtuxet Rivers and Boston and Providence Harbor in Planning Area No. 9 are all badly degraded. In Planning Area No. 10 the Housatonic in its upper reaches and also below Derby, the Still below Danbury, the Naugatuck below Torrington, the Quinnipiac, the French, Quinebaug and Thames all have serious water quality problems.

Nutrient problem areas were found to occur in the Taunton, North, Charles, Neponset and Westport Rivers in Planning Area No. 9 and the Housatonic and Quinnipiac River of Planning Area No. 10 as well as in several tidal estuaries and numerous lakes and ponds.

Inadequate dilution conditions exist in the Merrimack and Nashua Rivers in Planning Area No. 7, the Connecticut, Ashuelot, Millers, Chicopee, Ware, Quaboag and Westfield of Planning Area No. 8 and the Pascoag and Rumford-Ten Mile of Planning Area No. 9.

Sedimentation problems occur as a result of the pulp and paper, textile, food processing and primary metals operations. Reservoirs and shallow reaches of the major rivers and tributaries have ample evidence of benthic deposits and sludge banks caused by the sedimentation of wood, textile and food solids.

Future water quality problem areas in Subregion B were derived using the procedure described in detail in Chapter 1 of this appendix. Briefly, it was assumed that by 1980 all waste sources would receive secondary treatment and the resulting water quality would be at least equal to that called for by the State and Federal Water Quality Standards. Residual waste loads after secondary treatment in the year 2000 and 2020 were compared with the 1980 waste loads after secondary treatment. If the residual was more than twice that of 1980, it was assumed that without additional treatment widespread violations of the existing water quality standards would occur and, therefore, advanced waste treatment or low flow augmentation would be required on a general basis. Where residual waste loads in 2000 and 2020 are greater than similiar loads in 1980 by a factor less than two but greater than one, it was assumed that violations of the water quality standards would occur. However, these violations would be limited in extent. Advanced waste treatment or low flow augmentation or both would be needed to reduce residual loads to 1980 levels to maintain existing water quality standards. Detailed studies would be needed to accurately determine this need. The following is a list of such factors developed from this procedure and the secondary treated waste loads shown in Table L-7(B) for each Planning Area.

Planning Area	1980	2000	2020
6	1.0	1.0	1.5
7	1.0	1.0	1.6
8	1.0	1.3	2.0
9	1.0	1.0	1.5
10	1.0	0.9	1.3

The above procedure indicates widespread problems and violations of the present water quality standards will not occur between 1980 and 2000 as a result of secondary treated non-industrial and industrial waste discharges. Limited problems, however should be expected in all Planning Areas of Subregion B. Detailed studies to accurately define the location and magnitude of these problems should be initiated. Widespread problems and violations of the present water quality standards can be expected between 2000 and 2020 in Planning Area No. 8 without proper remedial action.

Presently a Water Resource Council-Type II study is in progress in Planning Area No. 9. This study is being conducted in much greater detail than the NAR. Preliminary analysis of data obtained from river sampling indicates that many of the rivers of Planning Area No. 9 require additional measures of pollution control beyond secondary treatment to maintain existing water quality standards. In view of this detailed information exception is taken to the analysis presented above and Planning Area No. 9 will be considered to be a Planning Area within Subregion B where widespread problems and general use of higher levels of treatment beyond secondary will be needed through 2020.

The problems presently anticipated throughout the study period from the discharge of secondary treated non-industrial and industrial wastes will involve dissolved oxygen and nutrient levels. These problems should occur near present centers of population and industry.

COMBINED SEWER SYSTEMS

Presently 160 combined sewer systems serving 5,200,000 people collect, transport and discharge non-industrial, industrial and storm water wastes in Subregion B. These wastewater discharges are felt to be the causes of water quality problems although, at present, information is not available which accurately locates or adequately defines these problems. For purposes of this study, water quality problems associated with combined sewer overflows have been assumed to exist near municipalities presently having combined systems.

Typically, a combined system under rainstorm conditions discharges mixed stormwater and municipal sewage through overflow outlets. The frequency and unpredictability of these discharges which contain solids and bacteria require that swimming be prohibited and water uses restricted.

Future problems resulting from combined sewer overflows can be expected to increase throughout the study period as additional municipal waste due to population and economic growth is carried by the existing combined sewer systems. At present there is no generally accepted method of handling combined sewer overflows. Some studies indicate that in urban areas, serious pollution problems will remain

due to storm water runoff alone, even though complete separation of storm water and waste water is achieved and the waste water is adequately treated. Numerous research and development projects, are currently underway on this subject which, will result in more complete information and the development of feasible solutions to this problem early in the study period.

SEPTIC TANKS AND CESSPOOLS

Water quality problems associated with septic tanks and cesspools are presently known to occur along the Blackstone River. Undoubtedly there are other areas where this type of subsurface disposal system is also causing water quality problems at present. This is particularly true where lake front and coastal real estate developments are taking place at present.

Based on population increase and recreational development activity in the Subregion, future water quality problems from septic tanks and cesspools should be anticipated throughout the study period. These problems can be expected to occur in the suburbs of the larger cities and towns in the Subregion as well as near recreational lakes and coastal waters.

MINE DRAINAGE

Mine drainage is not known to be causing any water quality problems in Subregion B at present.

Future water quality problems from mine drainage are not anticipated in Subregion B.

THERMAL SOURCES

Problems associated with thermal discharges are varied. Increased water temperature raises the metabolic rate of aquatic organisms, which in turn raises their oxygen needs. Simultaneously, high water temperatures decrease the availability of oxygen in the water. Resulting adverse combinations of oxygen and temperature can cause death, poor reproduction, retarded development and disease in varying degrees in different species.

The same adverse combinations also inhibit a stream's waste assimilative capacity, requiring more advanced degrees of waste treatment to achieve a given water quality standard. Thus, municipal and industrial treatment costs will be increased without adequate control of thermal discharges.

A third kind of problem stems from increased algal growth which

is often stimulated by added heat. These organisms can be unsightly, cause taste and odor problems, and upon their death create a biochemical oxygen demand. In addition, large numbers of living aquatic plants draw oxygen from the water at night and on overcast days, further depressing dissolved oxygen levels at critical periods, again making the achievement of water quality standards more difficult. Current water quality studies indicate this phenomenon may already be present in the Subregion.

Electrical energy generation demands in Subregion B can be expected to increase two times by 1980, six times by 2000, and sixteen times by 2020. Over 97 percent of this demand will be met through stream driven turbines. On this basis the Subregion should expect water quality problems from the discharge of thermal effluents unless strict controls are implemented. The thermal pollution water quality problem areas will probably occur in Planning Areas No. 6, 8, 9 and 10.

RECREATIONAL AND COMMERCIAL NAVIGATION

Water quality problems specifically related to recreational navigation wastes appear to be periodic and localized in Subregion B at present.

Problems associated with commercial navigation are present in several of the rivers and coastal waters. Portland Harbor in Planning Area No. 6, Gloucester, Boston, and Providence Harbors in Planning Area No. 9, and New Haven in Planning Area No. 10 all have waters that are degraded by commercial navigation.

As discussed in Section IV of this Chapter, recreational and commercial navigation can be expected to quadruple by 2020. Based on these projections, water quality problem areas associated with recreational and commercial navigation will probably occur throughout the study period. The most serious of these problems will be oil pollution and this type of problem will occur predominantely in the coastal waters of Planning Areas No. 6, 8, 9 and 10.

RURAL AND URBAN RUNOFF

Water quality problems associated with rural and urban runoff are not presently obvious in Subregion B. This does not mean that these problems do not exist, however, as they are easily masked by other types of water quality problems. Salt, a component of both urban and rural runoff, used for snow and ice removal, is responsible for a general lowering of water quality in all of the Planning Areas.

Future water quality problems associated with the rural and urban runoff should be anticipated in Subregion B throughout the study period.

OCEAN DISPOSAL

Ocean disposal is not known to be causing water quality problems in Subregion B at present.

Future problems related to this activity should be anticipated. In this regard, the coastal waters of Subregion B could easily become degraded as a result of receiving the salts, brines, sludges and exotic wastes of the future.

Recently, the U. S. Army Corps of Engineers has taken the first positive action by any Federal or State agency in this matter. This agency has suspended all dumping licenses applicable to those waters. This type of action is needed and further the use of these waters as dumping grounds should be prohibited.

CONSTRUCTION ACTIVITIES

There are not at present any known water quality problems of serious magnitude being caused by construction activities in Subregion B. However, construction activities are usually of a temporary nature and, as a result, water quality problems associated with these actions receive little attention. The major water quality problems associated with construction concern silting which covers food areas and spawning zones, hinders light penetration, and causes turbidity which degrades aesthetic and re-use values. There is ample evidence in the rivers of the Subregion that problems originating from construction activities exist.

Subregion B will experience considerable construction activity in the future, both in urban and rural areas. Transportation, industrial, housing, renewal, utility, recreational and other facilities will be needed for the population growths shown in Table L-3(B). Without careful contract requirements and inspection procedures, construction related water quality problems can be expected to occur.

VII. POLLUTION CONTROL ALTERNATIVES

SOURCE CONTROL

Prevention or control of waste at its point of origin is a practical means of reducing pollution. The development of new or improved industrial in-plant methods for the "wet process" industries of the Subregion, the collection of wastes in urban and rural areas for subsequent treatment and the regulation of effluent discharges are all important pollution control alternatives that can prevent the degradation of the surface waters of this Subregion.

New industrial processes or refinements in existing methods aimed at reducing the amounts of untreated waste generated at the source can result in a significant reduction in the amount of waste treatment plant capacity needed, as well as contributing to the upgrading of the waters of the Subregion. New technologies should be developed which are aimed at removing the pulp and paper, food processing, textile and primary metal operations from their historical positions as "wet process" industries to "dry process" types. approach should also be taken toward the "other industries" which presently discharge large quantities of wastewater to the municipal and regional systems of the Subregion, i.e. Metropolitan District Commission of Boston. Similiarly, technological advances in the electrical generation industry are needed so that "cooling water" needs are reduced sharply. As shown in Table L-7(B), the untreated industrial waste loads are expected to approach 13,400,000 P.E.'s in 1980, 23,800,000 in 2000, and 42,900,000 in 2020. The untreated industrial waste load in 2020 (42,900,000) will be over twice the untreated non-industrial (18,400,000). Although this ratio of untreated industrial waste loads to non-industrial waste loads in Subregion B is much less than a similar ratio in Subregion A the use of the process changes to reduce untreated industrial waste could be significant. Assuming that process changes can reduce these loads by only five percent, 700,000 P.E.'s in 1980, 1,200,000 in 2000, and 2,100,000 in 2020 will not require secondary treatment. The resulting savings in treatment plant construction costs throughout the study period is substantial. Cost estimates developed and discussed below in the subparagraph entitled Financial found that the 1967 average price of providing secondary treatment for all of Subregion B for the waste loads of the three target years during the study varied as follows: \$46/PE in 1980, and \$51/PE in 2000 and 2020, respectively. Based on these figures and the five percent reduction in untreated waste loads, process changes can represent a savings of over \$200,000,000 in treatment plant construction between now and 2020.

The cities and towns of Subregion B need a practical and economical method of controlling combined sewer overflows. Present methods and costs are such that any serious effort to control these overflows is most likely to occur only in areas of intensive water

use where overflows are frequent. Alternate methods of control include separation of storm and sanitary systems, interception and partial treatment, and interception and discharge to a larger body of receiving water. Estimates discussed in paragraph D indicate that with present day methods an investment of \$1.6 billion, would be required to control present discharges.

Many of the cities and towns have old and deteriorating collection systems, some of which date back to the early 1900's. They often carry large volumes of groundwater infiltration and sometimes transport their wastes to multiple outfalls. Methods of preventing or controlling ground-water infiltration in collection systems would increase the useable capacity or efficiency of the systems and also of the required treatment plants. Although there are not any estimates available to show the savings involved, the reduction is felt to be considerable. This is especially true in regard to reduced capital and operating costs for treatment plants. The installation of interceptors, capable of cutting off the present use of multiple outlets and conveying these wastes to a central point for treatment, is needed to eliminate raw waste discharges to the receiving waters.

Collection systems also can be extended to prevent pollution at the source, especially in high population density sectors, in both urban and rural areas. Where development is proceeding at a rapid rate, builders should be required to install collection systems before local officials issue building permits. This concept is especially important on land bordering recreational ponds, lakes, rivers and coastal waters where the almost universal use of septic tanks and leaching fields has caused serious problems.

The control of thermal discharges is possible either by providing cooling processes at existing plants, or locating new plants where the effect on the receiving water is small. The trend toward ever larger power plants with more economical ways of transmitting power over long distances, and the tremendous requirements for new generating capacity, all point strongly to the need for careful selection of new plant sites.

In the future, special problems occuring as a result of pressures to allow the dumping of exotic type wastes, as well as the end products of secondary and advanced waste treatment processes (sludges, salts, etc.) should be anticipated in the territorial and international waters (including the contiguous zone) adjoining Planning Areas No. 6, 8, 9, and 10. Alternatives include evaluation of ways to reduce volumes of these wastes at the source or alternate methods of disposal. As in the past and as exists presently in other coastal areas of the U. S., pressures will be exerted to allow the alternative of dumping to take place without knowing in advance what effect the act will produce. This is not an alternative, and should be legally prohibited.

TREATMENT ALTERNATIVES

A number of methods are available as treatment alternatives. For purposes of this study, however, only secondary and advanced wastewater treatment and regulation, and specifically, low flow augmentation, have been considered.

Throughout the study period secondary treatment or its equivalent should be required and maintained as the minimum acceptable level of treatment for all biodegradable wastewater discharges in Subregion B. It is recognized, however, that a few local areas will require additional measures. Wastes containing other than biodegradable material should receive an equivalent degree of treatment. Effluents containing domestic sewage or pathogenic organisms should be disinfected.

The need for advanced waste treatment and low flow augmentation on a broad Planning Area basis was also investigated in a preliminary way. The procedure utilized is outlined in detail in Chapter 1. A discussion of this procedure along with the results of this analysis is presented above.

On this basis, general use of advanced waste treatment or low flow will not be required in the Planning Areas of Subregion B before 2000. By 2020 advanced waste treatment or low flow augmentation will be needed on a general basis in Planning Area No. 8.

In addition to the North Atlantic Water Resource Study, there have been a number of interagency water resource studies in portions of Subregion B. These studies and others all with much greater detail than is possible with a Type I study have identified specific reaches of several rivers where additional flow or advanced waste treatment or both will be required to meet water quality standards by 1980.

Regionalization, an important concept, deserves serious consideration during the planning, design, and construction stages of both secondary and advanced waste treatment plants in Subregion B. An economic and water quality analysis for a single treatment facility to serve several adjoining communities should be a required alternate to a similiar analysis of a single treatment plant for each municipality, whenever federal funds are appropriated for the planning, design, or construction of these facilities. Both the single plant and regionalization concept should be analyzed within the framework of a complete river basin or basins.

STUDY NEEDS

Various water quality and pollution study needs for Subregion B have evolved as a result of work on this Appendix. The following tabulation is a list of these study needs.

- 1. Water Resource Council Type II studies or other detailed investigations in each of the Planning Areas.
- 2. Studies to develop optimum "wet process industry" land and water siting plans for each of the Planning Areas.
- 3. Studies to determine existing and potential nutrient problem areas. Consideration should be given to the impact of the highly treated non-industrial and industrial wastes of the future on these areas. In addition, studies to develop ways of removing nitrates and phosphates from these wastes are also needed.
- 4. Studies of existing Federal and state water quality laws and cost sharing procedures as they apply to the problems in Subregion B.
- 5. Studies to develop regional solutions to water resource and water quality problems, within a river basin framework.
- 6. Studies to determine the best methods of temporarily disposing of treatment plant sludges and exotic wastes in <u>international</u> waters, and which sea areas adjacent to Planning Areas No. 6, 8, 9, and 10 are best suited for temporary disposal.
- 7. Studies to find the best alternates of "ultimate disposal" for treatment plant sludges and exotic wastes.
- 8. Studies of existing laws that apply to water rights, water use and water needs. Many existing water right laws presently give almost unilateral control of flows to industries in Subregion B.
- 9. Studies to determine the professional and technical manpower needs to plan, design, construct, operate and maintain the wastewater treatment plants and water quality management program in Subregion B.
- 10. Land use and water use studies to determine the costs and benefits of raising or enhancing water quality standards.
- 11. Studies to define and assess the location and magnitude of industrial waste presently discharging to the large municipal and regional sewer systems in the Subregion.
- 12. Studies to define and assess the location and magnitude of combined sewer, septic tanks and cesspool, thermal, rural and urban runoff, and construction related water quality problem areas, and to define feasible alternatives to control these types of pollution.

OTHER NEEDS

- 1. <u>Legal</u>: The following legal needs are considered essential in Subregion B:
 - a. Legislation revising the proposed water quality standards of the States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island.
 - b. Enforcement of the water quality standards. This is especially critical in regard to maintaining established implementation schedules of wastewater treatment plant construction.
 - c. Legislation requiring the mandatory certification of wastewater treatment plant operators.
 - d. Legislation which will prevent the discharge of sludges and exotic wastes in the coastal or international waters (including the contiguous zone) adjoining Subregion B by Federal, state, or municipal governments or private industries operating in the United States.
 - e. Legislation to regulate land use, especially lands adjoining the rivers, lakes, ponds and coastal waters of Subregion B.
 - f. Legislation to regulate and reduce the use of subsurface disposal systems in Subregion B.
 - g. Legislation adopting a Boat Pollution Control Law.
- 2. <u>Manpower</u>: A recent study 1/ by the FWQA has found that during 1968 the following numbers of non-industrial wastewater treatment plant operators were on duty in the New England States.

State	Number
Maine	65
New Hampshire	70
Vermont	70
Massachusetts	380
Connecticut	435
Rhode Island	140
	1,160

^{1/} Manpower Needs at Water Pollution Control Facilities in New England FWPCA, June 1969.

By 1977 an additional 1,450 non-industrial wastewater treatment plant operators will be required. Estimates of industrial wastewater treatment plant operators are not available. Additional trained personnel are also essential for administration of state and regional water quality management programs, for surveillance and enforcement, and to carry on planning functions. Recruiting programs, training programs, and personnel position and pay classification reforms should receive serious consideration to meet expanding manpower requirements.

- 3. Research and Development: Important research and development needs in Subregion B are as follows:
 - a. Methods of producing paper, textiles, food and primary metal products, economically which do not (1) require the use of large quantities of water and (2) which do not generate large quantities of untreated waste loads. This research and development need should go beyond the examination of existing in-plant manufacturing techniques in these "wet process" industries to the development of entirely new methods which are aimed at changing these industries to "dry process" types. This need calls for a technological change not in the method of wastewater treatment but rather in the historic methods of manufacturing paper, textiles, food and primary metal products.
 - b. Developments or refinements in the present manufacturing methods of the paper, textile, food and primary metals industries, (1) which will reduce the generation of the present large quantities of untreated waste and (2) which will not require the use of the large quantities of water.
 - c. Methods of wastewater treatment which in combination with the developments suggested in b. above will bring about the almost complete reuse of water during the industrial processes associated with the manufacture of pulp and paper, textiles, food and primary metal products.
 - d. Economical electrical generation methods which do not require large quantities of cooling water. For example, full scale magnetohydynamic (MHD) facilities should be developed without delay.
 - e. An economical way of collecting, transporting or treating waste loads in unsewered urban and rural areas. This is especially significant in lake front and coastal water development areas.

Technological advances in the above areas aimed at reducing the amounts of <u>untreated waste load generated</u> will do the most over the study period to upgrade and enhance the waters of Subregion B.

4. Public Support: In the final analysis, the people of Subregion

B will decide through democratic processes what use is to be made of the water resources of this part of the study area. Whether or not the decision they reach is in the best interest of the majority of the residents depends on how well they and their leaders are informed of the facts concerning their environment and the consequences of their decision, or indecision. In studies like the NARS, every effort should be made to keep the public and their elected representatives informed, to stimulate their interest, and to enlist their support for water resource planning and development at the start and throughout the study.

5. Financial: Estimates of the financial investment required for water quality control in Subregion B have been prepared for the design years 1980, 2000 and 2020 and are presented in Table L-9(B). The figures represent the capital investment that would be needed to build wastewater treatment plants capable of treating projected waste loads for each of these target years for secondary wastewater treatment, advanced wastewater treatment and for combined sewer overflow control. In practice wastewater treatment facilities are sized to accommodate the projected growth in waste loads over a 20 to 25 year economic plant life. This, plus the actual timing of plant construction, the rate of physical obsolescence and salvage values will determine actual expenditures over the study period. maintenance costs for these facilities as well as expenditures needed for the construction of collection systems and the ultimate disposal of sludge is also not included. The figures, therefore, serve only to indicate the order of magnitude of financial investment in wastewater treatment plants needed in Subregion B for water quality control and to serve as a common basis of comparison with other Subregions. They are not intended to set or replace estimates developed as the result of detailed engineering studies for specific municipalities or industries.

Cost estimates for secondary wastewater treatment in Subregion B were determined by developing an average cost per population equivalent, to provide this type of wastewater treatment in each planning area, and applying this figure to the untreated waste loads of the area. The average cost per PE varies for each planning area and each target year during the study period. These average cost per PE figures were developed from an analysis of similar costs prepared in a recent study of pollution control needs in the New England States. This study considered all known pollution sources individually, and developed the costs of providing secondary wastewater treatment for these sources by utilizing consulting engineering, state classification and state agency reports and generalized wastewater treatment plant cost curves. As a result, the average cost per PE developed for use in this appendix is considered to reflect the numbers and

^{1/} Report on Immediate Pollution Control Needs, New England Rivers Northern and Southern Area - FWPCA, June 1967.

TABLE L-9(B)

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL^{a/}
SUBREGION B

Year	Estimated Cost of Secondary Treatment <u>b</u> /	Estimated Addi- tional Cost of Advanced Waste Treatment ^C	Other Cost ^d
Planning Area No. 6			
1980 2000 2020	100,000,000 170,000,000 261,000,000	(15,000,000) 22,000,000	57,000,000
Planning Area No. 7 1980 2000	210,000,000 368,000,000	(26,000,000)	153,000,000
2020 Planning Area No. 8	558,000,000	40,000,000	
1980 2000 2020	241,000,000 339,000,000 610,000,000	(68,000,000) 122,000,000	295,000,000
Planning Area No. 9			
1980 2000 2020	198,000,000 455,000,000 692,000,000	(97,000,000) 149,000,000	905,000,000

TABLE L-9(B) Cont'd

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL

A

SUBREGION B

Year	Estimated Cost of Secondary Treatment	Estimated Addi- tional Cost of Advanced Waste Treatment ^C	Other Costd/	
Planning Area No. 10				
			7/0 000 000	
1980	129,000,000	(24, 224, 222)	149,000,000	
2000	180,000,000	(26,000,000)		
2020	244,000,000	35,000,000		
Subregional	Total			
1980	878,000,000			
2000	1,512,000,000	(232,000,000)		
2020	2,365,000,000	368,000,000		
	4,755,000,000	600,000,000	1,559,000,000	

- <u>a</u>/ For general purpose planning only. Based on 1960 dollars. Costs not to be applied to any individual situation.
- $\underline{b}/$ Based on treating organic waste loads of both industrial and domestic origin. Treatment is considered to be 85% removal for the year 1980 and 90% for the years 2000 and 2020.
- Treatment which would remove, in addition to 95% Biochemical Oxygen Demand and 98% suspended solids, up to 98% of nutrients and up to 95% of other materials not removed by conventional treatment methods.() Although AWT is not expected to be used throughout in 2000 costs are figured and presented here on this basis. Detailed studies are needed to refine these estimates.
- d/ These costs are where known, estimates for combined sewer overflows control.

sizes of the wastewater treatment plants needed in each planning area. This analysis produced average secondary wastewater treatment costs per PE for each planning area that ranged from \$18 to \$62 in 1980, and from \$28 to \$85 in 2000 and 2020. These figures are relatively high when compared with similar figures developed for Subregion B. They reflect the numerous situations in Subregion B where the wastewater treatment plants are located in small or medium size waste loads to these systems.

Methods used to estimate the cost of advanced wastewater treatment and the control of combined sewer overflows are described in Chapter 1 of this Appendix.

The estimated cost of secondary wastewater treatment facilities sized to meet the 1980 waste loads will be on the order of \$878,000,000, \$1,512,000,000 for the year 2000 loads, and \$2,365,000,000 for the 2020 projected waste loads.

Although advanced wastewater treatment is not expected to be used on a general basis in Subregion B until the 2000 to 2020 period, costs for this type of wastewater treatment have been estimated for both the 2000 and the 2020 period load levels.

Costs to control combined sewer overflows have been figured as a one-time investment by 1980. On a Subregion basis this amounts to \$1,559,000,000.

VIII. POLLUTION CONTROL PROGRESS

Interstate

The New England Interstate Water Pollution Control Commission initially established in 1947 is a Congressionally authorized Compact organization. All six New England states and New York are member states of the Commission. The purpose of this organization has been to coordinate the water pollution control activities of the States on a regional basis in an area where many of the rivers and lakes are interstate. Through interstate cooperation, the Commission had been successful in establishing water quality classifications of many of the interstate waters of Subregion B before passage of the Water Quality Act of 1965. The Commission is continuing to resolve conflicts in the proposed water quality standards of the member states. One of the Commission's most interesting recent programs is the sponsorship of a wastewater treatment plant operators school. This school is a first of its kind in New England and will be a valuable source of trained wastewater treatment plant operators.

State

All of the states in Subregion B have established interstate water quality standards and have developed implementation plans for achieving these standards. The Secretary of the Interior has accepted these proposed standards as Federal standards.

All of the states in Subregion B have financial assistance programs to aid the cities and towns in the construction of wastewater treatment facilities. A brief summary of these programs follows:

Maine: The State of Maine will pay up to 30 percent of the construction costs eligible under the EPA grants program. A \$25 million bond issue was originally provided to finance this grant program. This was recently (1969) increased by an additional \$50 million. Maine does have pre-financing provisions.

New Hampshire: The State of New Hampshire will pay up to 40 percent of the construction costs eligible under the EPA grants. The State does not have a bond issue specifically set up to finance this grant program. Needed funds are appropriated from the regular State budget.

Vermont: The State of Vermont will pay 35 percent of the construction costs of all water pollution control facilities. This includes some portions which are not eligible under the EPA grant program. To date, the State has issued bonds in the amount of \$11.8 million to finance this program. Vermont does have pre-financing provisions.

Massachusetts: The Commonwealth of Massachusetts has a grants program which pays 25 percent of the construction costs eligible for a EPA grant. A \$150 million bond issue has been provided to finance this grant program. Massachusetts does have a pre-financing provision.

Connecticut: The State of Connecticut will pay up to 30 percent of the construction costs that are eligible under EPA grants. In addition, the State will pay 30 percent for the separation of storm and sanitary sewers. A \$250 million bond issue has been provided to finance this grant program. Connecticut does have a pre-financing provision.

Rhode Island: The State of Rhode Island will pay up to 25 percent of the construction costs eligible for a EPA grant. A \$12 million bond has been provided to meet the State's share.

In addition, the States of Subregion B are showing active interest in water and related land uses. New Hampshire, in 1967, enacted a law governing waste disposal on land abutting their waters. Any sewage system to be built or requiring extensive repair within one thousand feet of a surface water must have the approval of the State. Maine has enacted legislation which is aimed at regulating the site location of industrial and commercial development which may affect the environment. More reforms are being stressed for land zoning. Others are seeking stronger restrictions on flood plain protection and marshland preservations.

Federal

The Environmental Protection Agency has provided financial and technical assistance to the states within Subregion B.

The Water Quality Act of 1965, as amended, provides for a basic Federal share of 30 percent of eligible project costs. However, through a series of additional requirements involving both the states and municipalities, this basic grant can be increased to 33, 44 or 55 percent.

Between 1964 and 1968 the Environmental Protection Agency has participated in projects in the States covered by Subregion B that had a total eligible cost of almost \$234,132,000. EPA grants amounted to slightly over \$52,000,000 toward these projects.

In addition, the EPA has conducted water quality studies on various waters of Subregion B. These include the Merrimack River (Mass.-N.H.), Boston Harbor (Mass.), Charles River (Mass.), New Haven Harbor (Conn.), and portions of the Connecticut River (Vt., Mass., N.H., Conn.). Enforcement conferences have been held for the Merrimack, Boston Harbor, Blackstone and Ten Mile and the Connecticut.

IX. CONCLUSION

The water quality problems found in Subregion B are generally typical of those found in the other subregions of the North Atlantic Region. The Subregion is, however, distinguished from most other Subregions by certain geographic factors, the most notable of which is a relative abundance of water and land resources like Subregion A, but unlike Subregion A, a much greater population density. This is especially true in the Boston, Providence, Hartford, New Haven corridor. This has led to certain types of economic development and has caused some pollution problems to be more prominent than others. The most important of these are discussed below:

The first such problem concerns the danger of losing the valuable but presently unused fresh and coastal recreational waters to growing social and economic pressures, as well as the danger of destroying the present heavily used recreation waters. For both inland and coastal waters, there is an urgent need to protect all high quality waters from waste loads of local population centers, and from degradation by recreators themselves. The sharply increasing trend in vacation homes and transient recreation makes this task more difficult, but at the same time all the more vital. A most important and unique natural resource is available to Subregion B. Miles of natural salt water beaches lie literally minutes from the downtown centers of Portland, Boston, Providence, Hartford, and New Haven. Probably nowhere in the NAR are so many natural beaches located so close to metropolitan centers. Every attempt should be made to upgrade the water quality near these beaches as well as providing public access to these natural resources.

Special emphasis on ways to channel growth in the proper direction is essential since there is still time to safeguard most of the natural areas throughout the subregion, and a well balanced recreational environment is rapidly becoming a more and more valuable asset. Measures for planned land use, legal controls to prevent contamination from new and existing waterfront homes and improvements, strict requirements for sewage conveyance and treatment and vessel pollution control should receive strong emphasis in future water resource planning and action throughout Subregion B.

A second problem area concerns the relatively large industrial waste load in Subregion B and the amount of this waste load which is (1) discharged from point sources to the surface waters and (2) discharged to the existing municipal, intermunicipal and regional systems in the Subregion.

The control of these wastes at their source is of prime interest, not only because of the widespread impact it will have on water quality throughout the Subregion, but also because of the large investment that will be required to handle, convey and treat these wastes.

Potential savings from a technological breakthrough in this area are a sufficient incentive to mount an unusually ambitious research and development program aimed at reducing the amounts of untreated waste generated at their source.

The size of industrial waste loads discharged (1) from point sources (3,800,000 P.E.'s) and (2) from "other industries" (2,500,000 P.E.'s) and of the costs to treat them raises special political and financial problems for Subregion B. In the first case, industrial wastewater treatment costs are eligible for federal and state construction grants only if the treatment is provided by the municipal-Thus, depending upon the accessibility of a municipal system an industry may or may not benefit from aid. In the second case, "other industries" are discharging 2,500,000 P.E.'s to large regional systems such as the MDC system of Metropolitan Boston. Non-industrial waste sources discharged 4,300,000 P.E.'s to these same systems. Therefore. the waste loads from "other industries" represents thirty-seven percent of the total waste load handled by these systems. These systems are also eligible for federal and state grants and will require large amounts of these public funds to enlarge, expand and construct interceptors, pumping stations, and secondary wastewater treatment plants due in no small part to the "other industries" loads. For this reason capital and operating cost sharing methods presently in effect should be reviewed and arranged so that these "other industries" pay their fair share.

A third pollution control problem which demands special attention is that of the combined sewer systems. It is a country-wide problem and intensive research and development is consequently already being done nationally that undoubtedly will apply to Subregion But, irrespective of new technologies which may be developed, special solutions to the combined sewer problem must be worked out on an individual basis. This involves a detailed investigation of each system to determine its hydraulic characteristics, its waste characteristics, its effect on water quality standards, the impact on affected water and land use, and the feasibility of alternative solutions. To date, because of the complexity and the urgency of other water quality problems, little has been done in Subregion B to gather the necessary basic data to evaluate the seriousness of the problem or take corrective action. In the future it will assume increasing importance and will demand concerted action to arrive at workable solutions.

A fourth pollution control problem which demands special attention involves the population density and urban and suburban growth anticipated for Subregion B. These factors would seem to indicate that Subregion B is a feasible area for intermunicipal and regional arrangements, both for joint use of wastewater pollution control facilities and for cooperative management arrangements. Studies of these possibilities are urgently needed.

These problems have been emphasized above because they have special significance to Subregion B. This is not to minimize the seriousness of the other water quality problems cited in this appendix. All are important, some perhaps more locally and others on a more general basis. Each, however, requires attention if the subregion is to have a quality of water in its lakes, streams, rivers, estuaries, bays and open ocean that is suitable for the legitimate development and support of all related activities.

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY

APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 4

SUBREGION C

ENVIRONMENTAL PROTECTION AGENCY
WATER PROGRAMS OFFICE
May 1972

CHAPTER 4

SUBREGION C

I. SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Chapter 4 is a report on Water Quality and Pollution in Subregion C of the North Atlantic Regional Water Resources (NAR) Study Area.

This report is intended to give broad base planners an insight into the problems, needs, demands and interrelationships associated with water quality and water pollution in Subregion C. The Summary Findings, Conclusions and Recommendations given in this section can provide a program of requirement patterns for water resources management from a water quality viewpoint.

Findings, Conclusions and Recommendations pertain specifically and generally to Subregion C. No attempt was made here to discuss inter-subregion perceptional categories.

SUMMARY FINDINGS

- 1. Subregion C is located in the center of the NAR Study Area and covers one-sixth of the entire Region's land area, some 29,000 square miles of land and 400 square miles of inland surface waters. With the exception of several counties in western Vermont, the Subregion is essentially the eastern half of New York State.
- 2. The three major drainage systems in Subregion C are the St. Lawrence River-Lake Champlain, the Hudson-Mohawk Rivers, and the New York Coastal Area Waters. Hydrologically, these systems have a drainage area of about 26,800 square miles with 410 square miles of inland surface waters.
- 3. The economy of Subregion C is diversified. The presence of 13,055,000 people, in the Subregion, demands an orientation toward service industries and a relatively low position in employment in water-using industries. The concentrations of people in Planning Area 13 especially emphasizes this situation. The population densities range from 5300 in Planning Area 13 to the characteristically low rural density of 42 persons per square mile in Planning Area 11. Along with this range of settlement patterns of Metropolitan Subregions in the NAR, is the accompanying disparity in importance of type of economic activity; Planning Areas 11 and 12 are much more dependent on water-using industries plus farming and recreation.

- 4. Projections show that Subregion C will maintain its relative economic position through the year 2020.
- 5. The waters of Subregion C are presently being used for various and, in many instances, conflicting purposes. The uses of these waters can generally be described within the following categories: Municipal and Industrial Water Supply, Recreation, Commercial Fishing, Commercial Navigation, Power Generation, Irrigation and Other. Of these uses, Municipal and Industrial Water Supply accounted for 2717 MGD of water used in 1960. By 2020, the Municipal and Industrial Water Supply Demand is projected to increase to 7006 MGD.
- 6. The two most important sections of this Subregion C, Chapter 4 are Section VI, "Present and Future Water Quality Problems" and Section VII. "Pollution Control Methods."
 - A. Source Control and treatment are the two most significant pollution control methods available to Subregion C.
 - B. There are many Study and Management Needs for Subregion C. Type II studies are needed in each Planning Area by the year 2000.
 - C. Research and Development, Public Support and Financial Assistance are especially needed in Subregion C.
 - D. The estimated cost of providing secondary treatment levels to all of Subregion C are: for 1980 \$1.6 Billion, for 2000 \$3.5 Billion and for 2020 \$6.1 Billion.
- 7. Waste sources within Subregion C are varied and numerous. The most significant are non-industrial and industrial activities, combined sewers, rural and urban runoff, septic tanks and cesspools, thermal discharges, recreational and commercial navigation, and ocean disposal of wastes.
- 8. Non-industrial and industrial sources of organic waste loads presently discharge 19 million P.E. of BOD to the waters of the Subregion. The pulp and paper industry accounts for approximately 30 percent of the total load. An equivalent percentage is produced by non-industrial sources making these the two largest contributors to organic pollution in the Subregion.
- 9. Planning Area 13 receives the largest amounts of non-industrial and industrial wastes.
- 10. Future untreated organic waste loads will increase to 41 million P.E.'s in 1980, 68 million in 2000 and 118 million in 2020. With secondary treatment levels, these loads will be reduced to 6 million

- P.E.'s in 1980, 7 million in 2000 and 12 million in 2020 which would then be discharged to the waters of the Subregion. By the year 2020, industrial waste loads are projected to account for 85 percent of the total organic waste load.
- 11. Inorganic waste sources exist in Subregion C though they are usually over-shadowed by the volume of non-industrial and industrial types of organic waste loadings. An overview of the agricultural sources, including amounts of inorganic sediments, can be obtained from consulting the attachment from the U.S. Department of Agriculture to Chapter One of this Appendix and consulting Appendices H, I, J, K and Q of the NAR Study Report.
- 12. Stormwater and municipal wastes are presently collected, transported and discharged through some 90 combined sewer systems within Subregion C. These systems serve an estimated population of 7,300,000 persons or about 60 percent of the Subregion's entire sewered population.
- 13. Numerous Pollution Control Methods are in use in Subregion C. There are, however, serious gaps in data availability, adequate methodology and pollution control surveillance for Subregion C.
- 14. Progress in Pollution Control in Subregion C is noteworthy particularly because of New York State's progressive approach to pollution control.

CONCLUSIONS

- All major water bodies in Subregion C are currently receiving treated or untreated non-industrial and industrial waste loadings.
- 2. In Subregion C the parts of all major water bodies in the vicinity of population and industrial centers are seriously degraded by pollution.
- 3. Often the uses of the Subregion's waters are hampered and even eliminated by this pollution.
- 4. Through 2020, Subregion C has a projected population of 22,955,000 which indicates that it will maintain an extremely high population density. This means that Subregion C will become progressively more urban in character and types of problems.

- 5. As a result of the implementation of water quality standards, a general trend toward increased use or multiple use of the surface waters of Subregion C can be expected.
- 6. The quality of the Subregion's waters will have a direct bearing on the success of any management requirements necessary to meet the NAR Study's three basic objectives of Environmental Quality, Economic Efficiency and Regional Development.
- 7. Organic pollution from both non-industrial and industrial sources is the most significant degrader of water quality in the Subregion.
- 8. Combined sewer overflows and inorganic pollutants are the next most serious problems in Subregion C.
- 9. Although Progress in Pollution Control is noteworthy in Subregion C, much more time, manpower, money, laws, education and institutional arrangements are needed before water of an adequate quality can be ensured so as to meet the demands and needs of this Subregion.

RECOMMENDATIONS

- 1. Since serious gaps in actual data relevant to water quality and pollution in Subregion C are now apparent, an effort should be made to collect this data.
- 2. Methodology and Rationale, as devised for this Study, should be further developed and refined. This should include factors to determine benefits, waste loadings and effects of regionalization.
- 3. Benefits and costs and who is to benefit and who is to pay for providing adequate water quality to Subregion C should be determined.
- 4. Water Quality Standards should be implemented, enforced and updated in-line with revised desires of society.
- 5. Research and development programs presently underway should be expedited and expanded especially in controlling combined sewer overflows and in developing economical methods of advanced waste treatment.

- 6. Research and development programs should be implemented for determining multiple feasible and economical methods of source control, collection systems and "other" uses of wastewater such as ground water recharge and irrigation.
- 7. The Study and Management Needs described in Section VII, especially conducting Type II Studies by the year 2000 for all three Planning Areas, should be fulfilled.
- 8. Involvement and education of people in environmental study and control is necessary for pollution control.
- 9. It is recommended that a full-scale study be made of the powers, responsibilities and other factors involved in multi-community, multi-level government service agencies, so that administrative means be developed to implement the recommendations of this report.

FIGURE C-1

MAP OF

SUBREGION C

LOCATION AND BOUNDARIES

(Located in back of book)

TABLE L-1(C) SUBREGION C - PLANNING AREAS

Planning Area	Grouping of Whole Counties in the	Complete and Partial Major River Basins Within the
Number	Planning Area	Planning Area
11	Addison, Vt. Chittenden, Vt. Franklin, Vt. Grand Isle, Vt. Lamoille, Vt. Orleans, Vt. Rutland, Vt. Washington, Vt. Clinton, N.Y. Essex, N.Y. Franklin, N.Y. St. Lawrence, N.Y.	St. Lawrence River, Lake Champlain and Lake Memphremagog
12	Bennington, Vt. Albany, N.Y. Columbia, N.Y. Dutchess, N.Y. Fulton, N.Y. Greene, N.Y. Hamilton, N.Y. Herkimer, N.Y. Oneida, N.Y. Orange, N.Y. Putnam, N.Y. Rensselaer, N.Y. Rockland, N.Y. Saratoga, N.Y. Schenectady, N.Y. Schoharie, N.Y. Ulster, N.Y. Warren, N.Y. Washington, N.Y.	Hudson-Mohawk Rivers
13	Bronx, N.Y. Kings, N.Y. Nassau, N.Y. New York, N.Y. Queens, N.Y. Richmond, N.Y. Suffolk, N.Y. Westchester, N.Y.	New York City, Long Island and Westchester County Coastal Area

TABLE L-2(C)

SUBREGION C - MAJOR RIVERS AND TRIBUTARIES

Water Body	Length (miles)	Drainage Area (square miles)
PLA	NNING AREA NO. 11	
ST. LAWRENCE RIVER BASIN		
St. Lawrence River	235	303,000
Grass River	110	676
Raquette River	158	1,256
St. Regis River	94	825
Salmon River	47	410
Chateaugay River	75	163
Lake Champlain Basin		
Great Chazy River	49	296
Saranac River	89	614
Little Ausable River	26	68
Ausable River	20	518
Bouquet River	49	278
Ticonderoga Creek	41	_
Champlain Canal	25	_
Mettawee River	45	437
Poultney River	39	261
Otter Creek	105	941
Winooski River	90	1,065
Lamoille River	84	716
Missisquoi River	88	617
Lake Memphremagog Basin		
Clyde River	36	142
Black River	33	135
PL/	ANNING AREA NO. 12	
HUDSON RIVER BASIN		
Hudson River	315	12,650
Schroon River	68	568
Batten Kill	59	441
Kayaderosseras Creek	34	252
Hoosic River	72	730
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TABLE L-2(C) (Cont'd)

SUBREGION C - MAJOR RIVERS AND TRIBUTARIES

Water Body	Length (miles)	Drainage Area (square miles)
	PLANNING AREA NO. 12 (Cont'd))
Mohawk River	155	3,462
West Canada Creek	70	562
East Canada Creek	37	291
Kinderhook Creek	51	512
Catskill Creek	42	417
Esopus Creek	68	425
Rondout Creek	61	411
Wallkill River	90	786
Wappinger Creek	34	208
	PLANNING AREA NO. 13	
NEW YORK CITY WESTCHESTER COUNTY LONG ISLAND COASTAL	_	1,645 <mark>a</mark> /

a/ Total land Area in NAR Planning Area No. 13.

II. DESCRIPTION OF SUBREGION

LOCATION AND BOUNDARIES

Subregion C is located in the center of the North Atlantic Region and covers one-sixth of the entire Region's land area, some 29000 square miles of land and 400 square miles of inland surface waters. With the exception of several counties in Western Vermont, the subregion is essentially the eastern half of New York State. The geographical location and boundaries of the Subregion are shown in Figure C-1.

Subregion C is divided into three water resource planning areas; each planning area consists of one or more whole counties. Table L-1(C) lists the Planning Areas, the counties and the whole or partial river basins in each planning area.

PHYSICAL FEATURES

Hydrology: The three major drainage systems are the St. Lawrence-Lake Champlain, the Hudson-Mohawk, and the New York Coastal Area Waters. The location of each of these systems is shown in Figure C-1. Hydrologically, these systems have a drainage area of about 26800 square miles with 410 square miles of inland surface waters. The lengths and drainage areas of the major rivers and tributaries are presented in Table L-2(C). Additional hydrologic data are presented in Appendix C, "Climate, Meteorology, and Hydrology," of the NAR Study Report.

Geology: The Subregion is divided into the following physiographic areas: Planning Area 11, which is a part of the St. Lawrence Valley, the Adirondack, and the New England Provinces: Planning Area 12, which is a part of the Adirondack, the Catskill and the Taconic Mountains, along with the Hudson, Mohawk and Wallkill Rivers Valleys; and Planning Area 13, which is a part of the Atlantic Coastal Plain.

For specific information on the actual geology by location in the Subregion consult Appendix D, "Geology and Groundwater," of the NAR Study Report. The effects of bedrock on wastewater disposal systems and groundwater supplies is discussed in Chapter One by type of soil and bedrock.

CLIMATE

Typical Temperate Zone seasonal fluctuations occur. The inland mountain sections in the two upper or northern areas of the Subregion have seasonal temperature variations of about 50°F. The winters are

long and cold with annual minimum-maximum temperatures averaging $5^{\circ}F$ to $30^{\circ}F$ for January and the summers are moderate with July annual minimum-maximum temperatures averaging $50^{\circ}F$ to $85^{\circ}F$.

The coastal areas have a $40^{\circ} F$ seasonal temperature variation with hot summers. July temperatures average $65^{\circ} F$ to $85^{\circ} F$ while January temperatures average $20^{\circ} F$ to $40^{\circ} F$.

The two northern Planning Areas Numbers 11 and 12, receive over 100 inches per year precipitation in the form of snow, and about 40 inches per year of rainfall. The coastal Area, Number 13, receives an average of 25 inches of snow and about 50 inches of rain annually.

For a more detailed location analysis of climate in the Subregion, consult Appendix C, "Climate, Meteorology and Hydrology," of the NAR Study Report.

III. ECONOMY

SELECTED ECONOMIC MEASURES

The Subregion encompasses 40 counties, the greater New York City Standard Metropolitan Statistical Area, (SMSA) and two other SMSA's and over 20 urban centers.

In 1960, the Subregion's population was 13,055,000 with a very high subregional population density of 450 persons per square mile. The population densities range from the highest in the NAR of 5300 persons per square mile in Planning Area 13 to the characteristically low rural density of 42 in Planning Area 11. Through 2020, the Subregion has a projected population of 22,955,000 which indicates that it will maintain an extremely high population density and will become progressively more urban in character. Although it has the highest population, total employment, and per capita personal income, Subregion C has the second highest manufacturing employment and only the third highest employment in the six major water-using industries.

Although Subregion C has the second highest manufacturing employment the Subregion ranks only fifth in the ratio of manufacturing to total employment, and is projected to retain this position. This is also true in the comparison of the six major water-using industries to total employment ratios. Thus, domestic sewage problems, associated with the Subregion's large populations, will remain of primary concern when comparing potential water quality problems in the six NAR Subregions.

Detailed economic data on Subregion C are presented in Appendix B, "Economic Base," of the NAR Study Report. Selected summary data are presented in Table L-3(C).

TABLE L-3(C)

SUBREGION C - SELECTED ECONOMIC MEASURES

ECONOMIC MEASURES	1960	1980	2000	2020
Population	13,055,000	15,801,000	19,121,000	22,955,000
Total Personal Income (\$000) (1958 Dollars)	35,245,300	78,571,100	162,432,300	328,497,800
Per Capita Income ^{a/} (1958 Dollars)	2,717	4,973	8,495	14,311
Total Employment	5,247,800	6,647,200	8,054,100	9,604,800
Agriculture + Forestry + Fisheries	66,600	46,700	34,600	25,300
Mining	9,900	7,100	6,600	6,000
Total Manufacturing	1,455,100	1,459,700	1,406,000	1,508,800
Six Major Water-using Industries Total	344,500	331,300	326,400	338,300
20 Food and Kindred Products 22 Textile Mill Products 26 Paper and Allied Products 28 Chemicals and Allied Products 29 Petroleum Refining 33 Primary Metals	124,500 66,800 50,300 61,400 8,500 33,000	112,200 53,200 52,200 72,600 3,400 37,700	106,300 39,700 53,200 84,100 1,700 41,400	102,400 30,500 57,600 101,400 1,000 45,400
All Other Manufacturing Employment	1,110,600	1,128,400	1,079,600	1,170,500
Armed Forces (number)	37,700	33,100	33,100	33,100
All Other Employment Categories	3,678,500	5,100,600	6,573,800	8,031,600

 $[\]underline{a}$ / Based upon 1959 population and personal income reported in 1960 Decennial U.S. Census.

Source: North Atlantic Regional Water Resources Study, Appendix B, Economic Base,
Prepared by Office of Business Economics, Regional Economics Division, U.S. Department of Commerce.

IV. PRESENT AND FUTURE WATER USES

GENERAL

The waters of Subregion C are presently being used for many and, in some instances, conflicting purposes. The uses of these waters can generally be described within the following categories:

Municipal and industrial water supply Recreation
Commercial fishing
Commercial navigation
Power generation
Irrigation
Other

How these waters will be utilized will depend on their future water quality. The quality will have a direct bearing on the success of any management requirements necessary to meet the NAR Study's three basic objectives of Environmental Quality, Economic Efficiency and Regional Development.

Information on the existing and anticipated use of these waters is contained in Table L-4(C). All waters shown are used for fishing. Since all will continue to be used in this manner, they will also be aesthetically pleasing. Many of these streams are already being used for multiple purposes. Several streams will have additional uses in the future, with a general trend toward restoration of recreational and water supply utilizations. The coastal waters of Area 13 are presently designated for shellfishing. In the future, however, the amount of shellfish utilization will depend on the water quality.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY 1/

In 1965, the total municipal and industrial (M&I) water use was 2376 MGD. Municipal demand, which includes that portion of industry served by municipal systems, amounted to 1681 MGD. The remaining 695 MGD was utilized by industries supplied from sources other than municipal.

Within the Subregion, municipal and privately owned water supply systems serve approximately 12.6 million persons, or 97 percent of the total subregional population.

^{1/} Source: NAR Study Report, Appendix R, "Present and Future Water Supply."

TABLE L-4(C) SUBREGION C - PRESENT AND FUTURE WATER USE $\frac{1}{2}$

Water Body	Wat Sup		Shell- fishing	Bathing	Fishing	Agric., Ind., Navig. & Other
	Legend	x = P	resent Use	0	= Future Use	
		PLANN	ING AREA NO.	11		
ST. LAWRENCE RIVER BAS	SIN					
St. Lawrence River	x	0		xo	хо	xo
Grass River	x	0		xo	xo	xo
Raquette River	x	0		xo	xo	xo
St. Regis River				o	xo	xo
Salmon River					xo	xo
Chateaugay River				0	xo	xo
Lake Champlain Basin	<u>.</u>					
Lake Champlain	×	0		xo	xo	xo
Great Chazy River	x	0			xo	xo
Little Chazy River	•				xo	xo
Saranac River	x	0			xo	xo
Little Ausable Riv	rer				xo	xo
Ausable River					xo	xo
Bouquet River					xo	xo
Ticonderoga Creek						xo
Champlain Canal						xo
Mettawee River				xo	xo	хo
Poultney River				xo	xo	xo
Otter Creek					xo	xo
Winooski River				xo	xo	xo
Lamoille River						xo
Missisquoi River						хо
Lake Memphremagog Ba	sin					
Lake Memphremagog	x	0		хо	xo	xo
Clyde River					xo	xo
Black River	х	0			xo	xo

Water Body	Water Supply	Shell- fishing	Bathing	Fishing	Agric., Ind., Navig. & Other
Legen	$\mathbf{d} \mathbf{x} = \mathbf{P}$	resent Use	0	= Future Use	
	PLANN	ING AREA NO	. 12		
HUDSON RIVER BASIN					
Hudson River	xo		xo	xo	xo
Schroon River				xo	xo
Batten Kill			xo	xo	хо
Kayaderosseras Creek				xo	xo
Hoosic River			0	xo	хо
Mohawk River	xo		xo	xo	xo
West Canada Creek	xo		o	xo	xo
East Canada Creek	0		xo	xo	xo
Kinderhook Creek				xo	xo
Catskill Creek			xo	хо	xo
Esopus Creek	xo		хо	хо	xo
Rondout Creek	xo		xo	xo	xo
Wallkill River	0		0	xo	xo
Wappinger Creek			O	xo	хо
	PLAN	NING AREA NO	. 13		
NEW YORK CITY WESTCHESTER COUNTY LONG ISLAND COASTAL AREA					
Coast and Tidal Waters	xo	xo	хо	хо	хо

 $[\]frac{1}{2}$ Water uses for the stream in general and not for any specific reach. $\frac{1}{2}$ Future uses are those called for in the water quality standards.

The major industrial water users are the chemical and food processing, pulp and paper products, and petroleum refining industries. These industries account for 93 percent of the industrial water use and contribute an organic waste load of 9,900,000 population equivalents (P.E.) and many toxic agents both of which have a substantial impact on water quality.

The rapidly expanding residential and industrial development in the Subregion is expected to continue at an even more accelerated rate throughout the design period. This will require a more extensive use of water. Estimates indicate that the total M&I water needs will be 2717 MGD in 1980, 4729 MGD in 2000 and 7006 MGD in 2020. The major increases in water use will probably occur in and around the present centers of population and industry.

RECREATION

Bathing 1/: The entire Subregion offers numerous beach and bathing opportunities which account for the great popularity of this water oriented sport activity. Bathing facilities can be found along the many natural and man-made lakes, ponds and pools scattered throughout the mountains and lowlands and along the barrier beaches of the Atlantic Ocean. These include municipal as well as privately owned facilities. The acreage now available for bathing - both fresh and salt water swimming - is approximately 1030 acres.

Based on projected recreation activity, bathing demand will increase about threefold by 2020 and require an additional 3200 acres in new beach development.

Boating 1/: Many of the water bodies are navigable and suitable for pleasure boating. Besides the major water bodies, another attraction for the boating enthusiast is the inland navigable waterway which interconnects the Hudson River, Lake Champlain, the St. Lawrence River and the Great Lakes.

Recreational boating is widespread throughout the Subregion and is becoming an increasingly popular pastime. The large number of marinas and yacht clubs is indicative of the extensive use of these waters for pleasure boating. There are at least seven hundred private and public marinas and yacht clubs in the Subregion.

Estimates indicate that boating in Subregion C will increase about one-and-a-half times over the present by 2000 and about two-and-a-half times by 2020. The development of marinas and associated facilities to meet these recreational needs will result in localized pollution problems unless regulatory and surveillance activity is provided.

^{1/} Source: NAR Study Report, Appendix M, "Recreation."

Sport Fishing 1/: Fresh water fishing is growing in popularity each year throughout most of the Subregion, but is understandably limited in the densely populated Metropolitan areas. The increase in the pollutional load into these waters has had a significant adverse effect on fish species; in many sectors, fish and aquatic life are non-existent.

However, other areas do have a wide variety of fishing opportunities; Table L-4(C) gives a summary of some of these locations. There is an abundance of both cold and warm water habitats including many high quality trout streams. Trout fishing in particular, has deteriorated in streams flowing through extensive agricultural lands or highly populated areas. The bulk of the fishing is done by tourists and vacationers in the upper reaches and tributaries of the waters of the Subregion.

Salt water fishing is usually limited to the eastern half of Planning Area 13.

Subregion waters will be subjected to growing use by fishermen in the future. For the Subregion an estimated 24.1 million man-days will be devoted to fishing in 1980; 28.5 in 2000 and 33.7 million man-days in 2020.

Wildlife and Waterfowl 1/: The occurrence of wildlife and water-fowl varies considerably in Subregion C. Big game hunting, i.e., whitetailed deer and black bear, occurs only in the northern Planning Areas where small game hunting is also excellent. Small game hunting is available but limited in Planning Area 13. However, Lake Champlain in Planning Area 11, the Hudson-Mohawk Corridor of Planning Area 12, and Planning Area 13 offers exceptionally good waterfowl hunting. Many segments of the New York Metropolitan area serve as resting places for waterfowl during migration periods, but, hunting here is limited.

Pollution caused by the discharge of domestic and industrial wastes, by agricultural runoff, by dredging, and the filling of marshlands to meet expanded residential and commercial needs has depleted the waterfowl population. Based on the number of million man-user-days estimated for hunting, the Subregion can expect an increase for this water oriented sport. In 1980, 4.9 million man-days will be devoted to wildlife hunting; this will increase to 5.6 in 2000 and 6.6 in 2020.

Improvements in water quality conditions and the preservation and enhancement of desirable natural land areas can aid in the development of this natural recreational resource.

^{1/} Source: NAR Study Report, Appendix O, "Fish and Wildlife."

COMMERCIAL FISHING 1/

The commercial fin and shellfish industry have been in Planning Areas 12 and 13 for many years. However, a combination of overfishing and man-made environmental changes, including those resulting from pollution, has reduced the value of the waters for this use.

Commercial fishing in Planning Area 11 is negligible.

Future use of the waters of Subregion C for commercial fishing is not quantifiable at this time; however, the use will increase in years to come. This is especially true with regard to the harvesting of shellfish; many of the closed shellfish beds will become harvestable when the amount of pollution entering these waters is reduced.

COMMERCIAL NAVIGATION2/

In the northern areas, (Numbers 11 and 12), the New York State Barge Canal and Lake Champlain are the principal waters for commercial navigation. The New York Barge Canal consists of four major interconnecting canals (Erie, Champlain, Oswego, and Cayuga-Seneca) which transverse the Erie-Niagara, Genessee, Oswego, Mohawk and Hudson River Basins. This canal system links the Great Lakes-St. Lawrence Riverway with the New York Harbor Complex. Commercial traffic on these waterways consists primarily of shallow-draft tankers and barges transporting petroleum products. Other shipments transport newsprint paper from Canada to New York Harbor with return shipments of fertilizer products and other commodities.

In Planning Area 13, a definite contrast is apparent. In the eastern sector the commercial boat traffic is insignificant while the western sector is the busy New York Harbor Complex. The total amount of water-borne commerce of the Port of New York exceeded 150,000 short tons in 1960. In addition, the Hudson River from Troy to the Atlantic is deep enough to accommodate ocean going vessels, and is extensively used for both freight and sightseeing commerce.

Commercial navigation will increase in Subregion C; estimates show that the annual tonnage will be 228 million in 1980, 342 million in 2000, and 514 million in 2020.

^{1/} See NAR Study Report, Appendix O, "Fish and Wildlife," for detailed monetary values.

^{2/} Source: NAR Study Report, Appendix K, "Navigation."

POWER GENERATION 1/

Hydropower: In 1960, there were 20 individual hydroelectric power plants in Subregion C. Total installed hydroelectric capacity exceeded 1610 MW in 1969.

Hydropower capacity in the Subregion is expected to decrease. The percentage of this type of power generation will be small in comparison to total electric power requirements. Hydroelectric power capacities will be 3710 MW in 1980, 8700 MW in 2000, and 26700 MW in 2020. Available information indicates that hydropower facilities will be installed in Planning Area 12 of the Subregion.

Steam: As of 1960, there were at least 19 fossil fuel steam electric generating plants with a total installed capacity of 10700 MW of electrical power located in the Subregion.

At present, the number and capacities of privately owned steam generating plants, such as industrial installations, is unknown.

The Consolidated Edison's Indian Point Power Plant located on the Hudson is the only thermal nuclear reactor in the Subregion at present. It has a capacity of 275 MW. However, other nuclear power generating plants are being considered for other locations on the Hudson River and on Long Island Sound.

Thermal pollution directly resulting from both public utility power plant sources and industrial activity can be expected to increase with the continued demographic and industrial growth of the Subregion. Electrical energy produced by steam driven turbines is expected to multiply sixteen times by 2020. The total steam electric capacities are to be 25500 MW in 1980, 67100 MW in 2000 and 172,600 MW in 2020. Facilities to meet these needs will probably be constructed in Planning Areas 12 and 13 where the majority of such stations are presently located.

IRRIGATION

Although irrigation can significantly increase rural income, in Planning Area 12 the ratio of irrigation water to total water is insignificant. Present use of water for irrigation in the Subregion amounts to 46,000 acre-feet. Estimates of future irrigation water use indicate that this use will quadruple by the year 2020, over 90 percent of which is projected to be used, will be used in Planning Area 12. Therefore, water for irrigation should be seriously considered in any comprehensive river basin planning in this Area.

^{1/} Source: NAR Study Report, Appendix P, "Power."

OTHER

Presently, a tremendous amount of wastewater and semi-solid wastes is dumped into the Subregion's fresh and salt waters for disposal. This use will be controlled so that other legitimate water uses are not restricted by these practices. Further information on these practices is given in Section V of this Appendix.

There are two other uses of the Subregion's waters which must be considered; farming of sea food and mining of sand and gravel. However, information on these is still in the developmental stage. Further information on these water uses will be contained in several of the Appendices to the NAR Study Report especially, G, H, O, T, and U.

V. PRESENT AND FUTURE WASTE SOURCES

GENERAL.

The wastewaters being discharged to the waters of Subregion C are considerable in volume and strength. They are distributed in such a way that essentially all of the major waters receive municipal, industrial, agricultural or all types of wastewater. Untreated, partially treated and treated wastes from non-industrial and industrial sources amounting to 15,400,000 population equivalents (P.E.) of BOD are being discharged to the waters of Subregion C.

Industrial discharges, consisting of wastes from all the major water-using industries, contribute 10,600,000 P.E.'s or slightly over 65 percent of the total load. The pulp and paper industry accounts for approximately 30 percent of the total load discharged. An equivalent percentage is discharged by non-industrial sources making these the two largest contributors to organic pollution in the Subregion.

Future untreated organic waste loads will increase to 53 million P.E.'s in 1980, 88 million in 2000, and 155 million in 2020. With secondary treatment these loads will be reduced to 8 million P.E.'s in 1980, 8.8 million in 2000 and 15.5 million in 2020 which will then be discharged to the waters of the Subregion. By the year 2020, industrial wastes will account for 85 percent of the total organic waste load discharged to the water.

Tables L-5(C), L-6(C) and L-7(C) summarize for Subregion C the present and future organic waste loadings generated and discharged to streams.

Other types of waste sources, both organic and inorganic, exist in Subregion C though they may be over-shadowed by the volume of non-industrial and industrial waste loadings. A more extensive analysis of all these sources is presented in the following paragraphs.

NON-INDUSTRIAL AND INDUSTRIAL

Non-Industrial Waste Loads: Presently, 486 known municipal, institutional and Federal sources discharge wastes to the waters of Subregion C. These wastes exert a biochemical oxygen demand of approximately 4,780,000 P.E. Selected information concerning these sources is summarized in Table L-5(C).

		D	EGR	E E O	F TRE	EATMEN		Systems	Systems	Combined
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated	Not Chlor- inating	Storm- Sewer Systems
11										
Number of Systems	109	-	46	49	7	7		12	49	34
Pop. Served (000)	293	_	56	221	7 3	16	-	44	50	177
Waste Load Disch.										
Calc. P.E. (000)	203		56	144	1	2	-			
12										
Number $\frac{12}{\text{of Systems}}$	280	7	97	116	15	44	3	40	135	45
Pop. Served (000)	1,216	<u>-</u>	483	576	20	124	3	257	721	507
Waste Load Disch.	_,			• • •			_			
Calc. P.E. (000)	884		483	374	8	19	-			
13										
Number of Systems	97	21	12	28	7	25	4	14	16	13
Pop. Served (000)	10,055	11	1,371	835	2,433	5,397	4 8	2,700	4,240	6,579
Waste Load Disch.	•		•		ŕ	-			•	•
Calc. P.E. (000)	3,692		1,371	543	973	805	-			
Subregion Total										
Number of Systems	486	28	155	193	29	76	7	66	200	92
Pop. Served (000)	11,567	11	1,910	1,632	2,456	5,537	11	3,001	5,011	7,353
Waste Load Disch.										
Calc. P.E. (000)	4,779		1,910	1,061	982	826				

 $[\]underline{1}$ / Includes waste loads from municipalities, institutions and Federal installations.

TABLE L-6(C) SUBREGION C - ESTIMATED PRESENT INDUSTRIAL WASTES SUMMARY

2 1	Digit SIC Group	Waste Load Before Treat. 1/ (Est. P.E.)	Number of Known Sources	W	ADEO ASTE Partial	U A C Y T R E A T Complete		Discharged 2/ Waste Load- (Est. P.E.)	Possible Pollutants Other Than Organic Load
20	Food Water Use MGD	3,980,000	67 7.06	8	3 .03	5 .51	51 5.65	2,000,000	SS ³ /,Grease,0il, Disease-Bacteria
22	Textiles Water Use MGD	4,140,000	28 18.86	3 5	3 .96	1 .04	21 12.86	2,220,000	SS, Color
26 4 k	Paper Water Use MGD	7,380,000	35 99.68	5 12.7	12 67.82	2 -	16 19.16	4,330,000	SS, Color, pH
28	Chemicals Water Use MGD	2,450,000	30 7.20		3 3	1 -	26 4.20	1,329,000	SS, Color, Oil, pH, Grease, Toxic Materials
29	Petroleum Water Use MGD	1,070,000	6 4.93		1 .96		5 3.97	555,000	SS, Oil, Grease
33	Primary Metals Water Use MGD	360,000	22 10.16	2 3.72	.09	1 .24	18 6.11	174,000	Toxic Metals, pH, SS, Oil
Sub	region Total Water Use MGD	19,380,000	188 147.89	18 22.29	23 72.86	10 .79	137 51.95	10,600,000	

 $[\]frac{1}{2}$ Calculated waste load generated by entire 2 digit SIC group activity. Derived from waste load before treatment and adequacy of waste treatment. $\frac{3}{2}$ SS - Suspended solids.

TABLE L-6(C)

SUBREGION C - ESTIMATED PRESENT INDUSTRIAL WASTES

PLANNING AREA NO. 11

2 1	Digit SIC Group	Waste Load Before Treat.1/ (Est. P.E.)	Number of Known Sources	W None	ADEO ASTE Partial	•	O F M E N T Unknown	Discharged _{2/} Waste Load ² / (Est. P.E.)	Possible Pollutants Other Than Organic Load
20	Food Water Use MGD	118,000	21 .78	4 • 04	2.02	5 .51	10	35,000	SS ³ /,Grease,Oil, Disease-Bacteria
22	Textiles Water Use MGD	28,000						14,000	SS, Color
26 i	Paper Water Use MGD	657,000	6 32.70		6 32.70			526,000	SS, Color, pH
า วัน 28	Chemicals Water Use MGD	30,000	4 1.07		2 .40		2 .67	19,000	SS, Color, Oil, pH, Grease, Toxic Materials
29	Petroleum Water Use MGD	7,000						3,000	SS, Oil, Grease
33	Primary Metals Water Use MGD	48,000	3.10				3 .10	24,000	Toxic Metals, pH, SS, Oil
<u>P1a</u>	unning Area Total Water Use MGD	888,000	34 34.65	4 •04	10 33.12	5 •51	15 .98	621,000	

^{1/} Calculated waste load generated by entire 2 digit SIC group activity.

^{2/} Derived from waste load before treatment and adequacy of waste treatment.

 $[\]overline{3}$ / SS - Suspended solids.

TABLE L-6(C) SUBREGION C - ESTIMATED PRESENT INDUSTRIAL WASTES PLANNING AREA NO. 12

	2 D	igit SIC Group	Waste Load Before Treat. 1/ (Est. P.E.)	Number of Known Sources	W .	A D E A S T E Partial	Q U A C Y T R E A T Complete		Discharged 2/ Waste Load (Est. P.E.)	Possible Pollutants Other Than Organic Load
	20	Food Water Use MGD	529,000	38 5.12	4 .83	.01		33 4.28	307,000	SS ^{3/} ,Grease,Oil, Disease-Bacteria
	22	Textiles Water Use MGD	1,090,000	21 17.46	3 5	3 .96		15 11.50	723,000	SS, Color
<u> </u>	26	Paper Water Use MGD	1,950,000	28 66.88	5 12.70	6 35.12	2	15 19.06	1,420,000	SS, Color, pH
L-234	28	Chemicals Water Use MGD	460,000	10 4.03		1 2.60	1	8 1.43	320,000	SS, Color, Oil, pH, Grease, Toxic Materials
	29	Petroleum Water Use MGD	65,000	1 .96		1 .96			52,000	SS, Oil, Grease
	33	Primary Metals Water Use MGD	96,000	14 9.51	2 3.72			12 5.79	67,000	Toxic Metals, pH, SS, Oil
	Pla	nning Area Total Water Use MGD	4,190,000	112 103.96	14 22.25	12 39.65	3	83 42.06	2,887,000	

 $[\]frac{1}{2}$ Calculated waste load generated by entire 2 digit SIC group activity. Derived from waste load before treatment and adequacy of waste treatment. $\frac{3}{2}$ SS - Suspended solids.

TABLE L-6(C) SUBREGION C - ESTIMATED PRESENT INDUSTRIAL WASTES PLANNING AREA NO. 13

	2 D	igit SIC Group	Waste Load Before Treat.1/ (Est. P.E.)	Number of Known Sources		QUACY TREAT Complete	MENT	Discharged ₂ / Waste Load ² / (Est. P.E.)	Possible Pollutants Other Than Organic Load
	20	Food Water Use MGD	3,340,000	8 1.16			8 1.16	1,670,000	SS ^{3/} ,Grease,Oil, Disease-Bacteria
	22	Textiles Water Use MGD	3,020,000	7 1.40		.04	6 1.36	1,470,000	SS, Color
5	26	Paper Water Use MGD	4,780,000	1 .10			1.10	2,390,000	SS, Color, pH
L-235	28	Chemicals Water Use MGD	1,960,000	16 2.10			16 2.10	990,000	SS, Color, Oil, pH, Grease, Toxic Materials
	29	Petroleum Water Use MGD	997,000	5 3.97			5 3.97	500,000	SS, 011, Grease
	33	Primary Metals Water Use MGD	220,000	5 .55	1 .09	.24	3 .22	83,000	Toxic Metals, pH, SS, Oil
	Pla	nning Area Total Water Use MGD	14,300,000	42 9.28	1.09	2 .28	39 8.91	7,100,000	

 $[\]frac{1}{2}$ Calculated waste load generated by entire 2 digit SIC group activity. Derived from waste load before treatment and adequacy of waste treatment. $\frac{3}{2}$ SS - Suspended solids.

TABLE L-7(C) SUBREGION C - PRESENT AND FUTURE ORGANIC WASTE LOADS SUMMARY

P.E. (000)			r.E. (000)	1.2. (000)		
<u>Year</u>	Before After Treatment Treatment Treatment		C/		Before Treatment	After Treatment	
1960	13,100 <u>d</u> /	4,780	19,390	10,600	32,500	15,400	
1980	15,800	2,370	37,700	5,630	53,100	8,000	
2000	19,100	1,910	69,400	6,940	88,400	8,800	
2020	23,000	2,300	132,000	13,200	155,000	15,500	

Industrial b/

Waste Load

P F (000)

Total

Waste Load

P.E. (000)

Non-Industrial

n = (000)

Includes waste loads from municipalities, institutions and Federal installations.

a/ Includes waste loads from municipalities, institutions and Federal installation b/ Includes the waste loads from the six major water-using two digit SIC groups.

c/ This is considered to be a result of actual treatment practice carried out in This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020.

Includes 1,488,000 persons not served by non-industrial waste collection systems.

2020

TABLE L-7(C) SUBREGION C - PRESENT AND FUTURE ORGANIC WASTE LOADS PLANNING AREA NO. 11

	P.E. (0	00)	P.E. (0	00)	P.E.	P.E. (000)		
Year	Before Treatment	After Treatment	Before Treatment	After Treatment <u>c</u> /	Before Treatment	After Treatment		
1960	512 <u>d</u> /	422	888	621	1,400	1,040		
1980	586	88	1,500	212	2,100	300		
2000	672	67	2,480	233	3,200	300		

4,240

Industrial

Waste Load

421

Total

5,000

Waste Load

500

79

Non-Industrial

Waste Load

786

Includes waste loads from municipalities, institutions and Federal installations.

Includes the waste loads from the six major water-using two digit SIC groups.

This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020.

Includes 219,000 persons not served by non-industrial waste collection systems.

TABLE L-7(C)

SUBREGION C - PRESENT AND FUTURE ORGANIC WASTE LOADS

PLANNING AREA NO. 12

P.E. (000)			P.E. (000)	P.E. (000)		
Year	Before After C/Treatment Treatment		C/		Before Treatment	After Treatment	
1960	1,980 <u>d</u> /	1,650	4,200	2,890	6,180	4,500	
1980	2,320	350	7,700	1,150	10,000	1,500	
2000	2,800	280	14,400	1,420	17,200	1,700	
2020	3,390	340	28,000	2,840	31,800	3,200	

Industrial b/

Total

Waste Load

Non-Industrial
Waste Load

a/ Includes waste loads from municipalities, institutions and Federal installations.

Includes the waste loads from the six major water-using two digit SIC groups.

This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020.

d/ Includes 766,000 persons not served by non-industrial waste collection systems.

TABLE L-7(C) SUBREGION C - PRESENT AND FUTURE ORGANIC WASTE LOADS PLANNING AREA NO. 13

	P.E. (00	0)	r.E. (000)	P.E. (000)		
Year	Before After Treatment Treatment		Before Treatment	After Treatment c/	Before Treatment	After Treatment	
1960	10,600 <u>d</u> /	4,200	14,300	7,100	24,900	11,300	
1980	12,900	1,940	28,500	4,270	41,000	6,210	
2000	15,640	1,560	52,500	5,254	68,000	6,818	
2020	18,800	1,880	99,400	9,940	118,000	11,814	

Industrial b/

DE (MAA)

Total Waste Load

የ የ (በበበ)

Non-Industrial

D E (000)

Includes waste loads from municipalities, institutions and Federal installations.

 $[\]frac{\overline{b}}{c}$ Includes the waste loads from the six major water-using two digit SIC groups. $\frac{\overline{b}}{c}$ This is considered to be a result of actual treatment practice carried out in This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020.

Includes 506,000 persons not served by non-industrial waste collection systems.

In 1960, approximately 90 percent of the total Subregion population, or 11,567,000 persons, was served by wastewater collection systems. About 15 percent of this population's waste was discharged to receiving waters untreated, 15 percent with primary treatment and 45 percent with secondary treatment.

It is estimated that in the future the entire population will be served by secondary waste treatment facilities. Projections for future waste loads from non-industrial sources can be found in Table L-7(C).

Industrial Waste Loads: Estimated industrial waste loads, summarized by major types of water-using industries, are presented in Table L-6(C).

The major water-using industries in the Subregion generate an organic waste load estimated at 19,380,000 P.E. Under present conditions of treatment, an organic waste load equal to that produced by 10,600,000 people is discharged to the waters of the Subregion. The largest portion of this amount comes from 188 known sources. In addition, the tanning industry which produces organic wastes, and industries such as the chemical, petroleum, paper, primary metals and mining operations which produce harmful inorganic wastes discharge to the waters of the Subregion. It is, however, beyond the scope of this study to determine the magnitude of these wastes or their effects on receiving waters.

The projected organic waste loads from the major water-using industries for the design years 1980, 2000 and 2020 are given in Table L-7(C). Analysis of this information shows that, although the untreated load is expected to increase seven times, the load after treatment could approximate that which is discharged today. Thus future industrial wastes will be an even more important aspect in determining water quality management programs in Subregion C.

COMBINED SEWER SYSTEMS

Stormwater and municipal wastes are presently collected, transported and discharged through 92 combined sewer systems within Subregion C. These systems serve an estimated population of 7,300,000 persons or approximately 63 percent of the Subregion's entire sewered population. Planning Area 13 has the smallest number (13) of combined sewer systems but serves over 6.5 million persons. For the purposes of this study, it is assumed that the number of combined sewer systems will decrease through the design period.

SEPTIC TANKS AND CESSPOOLS

Within Subregion C there are more than 800,000 separate housing units, as well as an unknown number of business establishments, which dispose of waste through septic tanks or cesspools. As the density of the Subregion's population increases, the combined effects of these individual disposal systems will become increasingly unsatisfactory. It is expected that through the design period there will be a significant drop in the percentage of individual systems in relation to the total population of the Subregion.

MINE DRAINAGE

There are no known mine drainage pollution problems in Subregion C.

THERMAL SOURCES

Heat can be a source of pollution resulting from the discharge of "hot" cooling water from fossil and nuclear powered electric generating plants and industrial establishments. Some 28 generating stations are currently operating in Subregion C. In addition, one nuclear generating station is operational and one more is in the construction stage.

Projections indicate a greater use of constant run-constant load nuclear or fossil fueled stations to assume the projected base loads with peaking requirements to be handled by the hydroelectric and fossil fueled stations. It is estimated that the power requirements in the year 2020 for Subregion C will increase some 18 times over the 1960 capacity of 11000 MW.

RECREATIONAL AND COMMERCIAL NAVIGATION

Recreational boating is an important use of the Subregion's waters with over 300,000 licensed craft in 1966. Recreational boating constitutes a source of pollution because of the discharge of human fecal matter, litter, motor exhaust and oil. The magnitude of these sources is unknown at this time. The majority of these problems are concentrated in and near the crowded marinas. With the expected increase in pleasure boating, many of these problems will be accentuated unless appropriate legislation is enacted and enforced.

The discharge of untreated human feces from watercraft in the Subregion represents a potential health hazard, particularly in the crowded marina areas. The States are moving slowly toward legislation for the control of these discharges.

The rapid growth of pleasure boating has resulted in an appreciable increase in dumping of litter, including such materials as plastic food wrap, and glass, metal and cardboard containers. These materials do not readily disintegrate. Some may flow onto the beaches resulting in the deterioration of the aesthetic quality of the environment.

The exhaust from outboard and certain inboard motors is discharged directly into the water, resulting in contamination by hydrocarbon residues. In restricted waters, such as the coves and inlets in Planning Area 13, the concentration of these residues may reach levels detrimental to aquatic life.

Oil pollution can occur as the result of careless operation of recreational boats. Due to the volume of oil involved, this problem is usually limited to restricted waters where large numbers of boats are concentrated, such as marinas.

The spillage of oil in commercial operations also contributes to the problem of pollution. This problem is largely confined to the major harbor areas in Planning Area 13. Spills resulting from pumping of bilges from damaged tankers and barges, or from transfer facilities, can cover large areas with sticky oil residue, making shore and waters unsuitable for recreation and causing great loss of marine life. Over 500 initial cases of oil pollution were investigated in the New York Harbor Area in 1966.

RURAL AND URBAN RUNOFF

Information is not available which accurately portrays the magnitude or types of waste loads that are being discharged to the surface waters of Subregion C by rural and urban runoff. Agricultural chemicals, primarily fertilizers and pesticides are spread in large quantities over the surface of the land. During periods of rainfall, excess chemicals are washed into the surface waters or percolate into aquifers. Indiscriminate spillage of sprays and improper disposal of empty pesticide containers can cause serious problems.

Urban runoff is an increasingly important wastewater that is reaching the surface waters of the Subregion. Urban runoff may contain oils, organic matter, trash, inert solids, salts, fertilizers and whatever else can be easily swept or washed into street gutters, storm sewer systems or the nearest water course. This problem is expected to grow steadily as the Subregion undergoes massive urban development.

OCEAN DISPOSAL

The ocean area known as the New York Bight has long been used as a site for the disposal of rocks, mud, dredgings, sewer sludge and industrial wastes. Over 15.4 million cubic yards of these materials were dumped in the New York Bight in 1966. The potential discharge to the ocean of the great variety of wastes could have serious ramifications. Not only can biota be destroyed, but concentrations of toxic elements can be put into the food chain, multiplied and returned to humans via seafood. Unless alternative ultimate disposal methods are found, it is virtually certain that the amount of wastes that will be disposed of in ocean waters will increase significantly through the design years.

CONSTRUCTION ACTIVITIES

Construction activities for both buildings and roadways is and will continue to be of significance in Subregion C. The physical disturbance of the soil cover allows a considerable amount of suspended solids to enter the surface waters of the Subregion. For further detailed information see Appendix Q, "Sediment and Erosion," of the NAR Study Report.

Washing sand and gravel at processing plants is a potential source of pollution by suspended solids; however, most producers remove suspended solids in settling ponds before final discharge. The current concern for water quality makes it unlikely that sand and gravel washing plants without settling ponds will continue to operate for more than a few years. For further detailed information, see Appendix H, "Minerals," of the NAR Study Report.

VI. PRESENT AND FUTURE WATER QUALITY PROBLEMS

GENERAL

In Subregion C the major water bodies near population and industrial centers are seriously degraded by pollution. Stream reaches which currently have water quality problems are shown graphically in Figure C-2 and tabulated in Table L-8(C). In discussing future water quality problems, it is assumed that by 1980 all sources will receive at least secondary treatment and that the resulting water quality of the receiving streams will be adequate to meet State and Federal Water Quality Standards.

Non-industrial and industrial waste loads are considered separately in the following paragraphs. It must be remembered that there are many heavily developed areas where both non-industrial and industrial wastewaters are in the same sewer system or in the same water body and cannot be easily identified separately.

For a more detailed discussion of future water quality problem areas resulting from discharges of these types of wastes, refer to Section VII, "Pollution Control Methods -- Treatment Alternatives" of this Appendix.

NON-INDUSTRIAL WASTE LOADS

Non-industrial waste loads include wastewater from municipalities, institutions and Federal installations. Most major water bodies in Subregion C are currently receiving treated or untreated non-industrial waste loadings. Continuation of existing abatement and implementation plans will cause the 1980 waste load to be about half the 1960 load. As a result of increased treatment, the waste loads discharged to streams in 2000 and 2020 will remain approximately at the 1980 levels even though the population will have increased.

Future problem areas for non-industrial waste loads in Subregion C will be the population centers adjacent to Lake Champlain in Planning Area 11; the Mohawk River downstream of Utica and the Hudson River downstream of the Albany-Troy area in Planning Area 12; and the New York Harbor area in Planning Area 13.

INDUSTRIAL WASTE LOADS

Many major water bodies in Subregion C are currently receiving treated or untreated industrial wastes. It is estimated that the 1960 industrial waste load generated was reduced by half by treatment.

FIGURE C-2

MAP OF

SUBREGION C

WATER QUALITY PROBLEM AREAS

(Located in back of book)

Water Body	Non- Indus <u>ī</u> /	Indus- trial	Thermal ² /	Septic Tanks & Cesspools	Naviga7 tion 3	Acid Mine Drain- age	Runoff ^{4/}	Other 5/
		PL	ANNING AREA N	0. 11				
ST. LAWRENCE RIVER BASIN								
St. Lawrence River	x	x	x	x	x		x	d
Grass River	x	x	x	x			x	a,b
Raquette River	x	x	x	x			x	a,b
St. Regis River	x							d
Salmon River	x							
Chateaugay River	x							đ
Lake Champlain Basin	x	x		x	x			ъ
Great Chazy River	×	x						a
Little Chazy River	x							
Saranac River	x	x						d
Little Ausable River	x							d
Ausable River	x	x						
Bouquet River	x							
Ticonderoga Creek	x	x						а
Champlain Canal	×				x			d
Mettawee River	x	x		x				
Poultney River	x	x		x				
Otter Creek	x	x		x				С
Winooski River	x	x		x				a,c
Lamoille River	x	x		x			x	
Missisquoi River	x	x		x				

Water Body	Non- Indusī/ trial	Indus- trial	Thermal ^{2/}	Septic Tanks & Cesspools	Naviga- tion 3/	Acid Mine Drain- age	Runof f ^{4/}	Other_5/
		<u>PI</u>	ANNING AREA N	0. 11 (Cont'	i)		.	
Lake Memphremagog Basin	x	x		x				
Clyde River	x	x		x				
Black River				x			x	
		PI	ANNING AREA N	10. 12				
HUDSON RIVER BASIN								đ
Hudson River	x	×	x	x	x		x	a,d
Schroon River	x	x		x			x	
Batten Kill	x	x					x	
Kayaderosseras Creek	x	×						
Hoosic River	x	x		x				С
Mohawk River	x	x					x	
West Canada Creek	x	x		x			x	С
East Canada Creek	×	x		x			x	_
Kinderhook Creek	x			x				đ
Catskill Creek	x	x	x					
Esopus Creek	x	x		×				c
Rondout Creek	x	x						a,c
Wallkill River	×	×	x					
Wappinger Creek	×	x						

TABLE L-8(C) (Cont'd)

SUBREGION C - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus <u>ī</u> / trial <u>ī</u> /	Indus- trial	Thermal ²	Septic Tanks & Cesspools	Naviga- tion 3/	Acid Mine Drain- age	Runoff ^{4/}	Other ⁵ /
PLANNING AREA NO. 13								
NEW YORK CITY								
WESTCHESTER COUNTY LONG ISLAND COASTAL	x	x	x	x	x		x	a,b

- 1/ Includes wastewater from municipalities, institutions, and Federal installations.
- 2/ Includes thermal wastes from industry and thermal power plants.
- 3/ Includes all types of wastes from commercial, recreational and Federal navigation.
- 4/ Wastewater containing: a) agricultural chemicals; and b) sediment from agricultural and urbanization or industrial operations.
- 5/ a. combined sewer systems
 - b. nutrient enriched water
 - c. inadequate dilution
 - d. suspect problems but not identified

Continuation of the abatement and implementation programs of New York and Vermont should halve the discharged load again by 1980. By the year 2020 the industrial waste load before treatment will be 132 million P.E.'s or nearly ten times the load of 1960, yet due to secondary treatment the projected load after treatment is estimated at 13.2 million P.E.'s.

COMBINED SEWER SYSTEMS

At present, there are 92 combined sewer systems serving some seven million people in Subregion C. Over 60 percent of the population served is served by combined sewer systems. It is estimated that there may be 20,000 million gallons per year of overflow (storm water runoff plus sewage) waters in Subregion C.

A basic assumption of the NAR report is that it is possible to design and implement, by the year 1980, the combined sewer control facilities needed in Subregion C. Systems carrying only storm drainage or urban runoff would not be a part of this program. It is also assumed that new sewer system construction will be separate sanitary or stormwater systems.

SEPTIC TANKS AND CESSPOOLS

The disposal of wastes through septic tanks and cesspools does not constitute a major problem in Subregion C. However, portions of all Planning Areas have experienced localized problems; notably the eastern half of Planning Area 13. Future implementation of existing State legislation should end most water quality degradation from this type of waste disposal in areas of increasing population density.

It is expected that some individual waste disposal systems of this sort will remain in existence in the lightly populated rural areas through the design period.

MINE DRAINAGE

There are no known mine drainage problems in Subregion C.

THERMAL SOURCES

Potentially, many of Subregion C waters will be affected by thermal pollution because of an anticipated rise in electrical power capacity for the design period. This pollution load will depend on the ability of the designers to tailor the new plants to meet established water quality criteria and standards.

Thermal pollution from manufacturing in Subregion C may well increase due to a projected rise in employment (and consequently, new plants) in the chemical and allied products industries. Conversely, it should be remembered that new processes as well as implant treatment alter individual waste loadings to water bodies.

RECREATIONAL AND COMMERCIAL NAVIGATION

Pollution by recreational boating is primarily in the waters of Planning Area 13, in waters with limited circulation and a high density of boats. Localized problems also occur in the other Planning Areas. Increases in recreational boating could mean a proportionate growth in this type of pollution.

Commercial navigation is limited to the harbor portions of Planning Area 13, the Hudson River, the New York Barge Canal, and the Lake Champlain Waterway. Localized pollution from oil spills and overboard waste disposal could increase due to expansion in the shipping industry.

Another problem related to navigation is maintenance dredging and dredging larger channels. With the expected increase in volume of shipping and ship size, greater amounts of spoil material will have to be disposed of. Suitable disposal sites which will not degrade water quality are becoming scarce.

RURAL AND URBAN RUNOFF

"Agricultural" runoff will increase in Subregion C through the design years. Although information is not available defining the movement of agricultural chemicals to the surface waters of the Subregion, an indication of the magnitude of this problem can be obtained from a review of the data on erosion and sedimentation in the NAR Study Report, Appendix Q, "Erosion and Sedimentation."

In Subregion C the erodibility of soils is slightly below the average for the entire NAR Study Area.

The average erosion rate for urban areas is estimated to be more than five times the rate for cropland. Planning Area 13 is presently composed of 52 percent urban land and 6 percent cropland (which is intensively farmed). Planning Area 12 incurs 85 percent of the current damages to Subregion C by erosion and 50 percent of the sedimentation damages.

The entire Subregion will suffer the effects of erosion and sedimentation through the design years. Planning Areas 12 and 13 will experience the greatest problems in the future. Erosion and sedimentation, along with runoff of agricultural chemicals, cannot be eliminated but can be reduced through conservation measures.

OCEAN DISPOSAL

Wastes, mainly from the New York Metropolitan Area (Planning Areas 13 and 14), are being dumped in the New York Bight. Currently, rocks, mud, dredging spoil, sewer sludge, and some industrial wastes are being dumped at sea. Since ocean dumping is often considered to be the least cost alternative among the various disposal methods, there is a high degree of interest in ocean disposal. Until the effect of industrial wastes on the pelagic biota is firmly established, ocean disposal should be minimized.

CONSTRUCTION ACTIVITIES

Increasing urban land use in the NAR Study Area is estimated at 150 percent by 2020. This transition period may increase the erosion and consequent sediment load as much as 75 times the current rate. For further discussion refer to the previous section on RURAL AND URBAN RUNOFF.

VII. POLLUTION CONTROL METHODS

SOURCE CONTROL

The most effective method of protecting the water quality of the Subregion is to prevent pollutants from entering the water. The reduction of the waste loads, the reduction of wastewater volumes, and the alteration of waste load characteristics at their source are some of the methods which can simplify water pollution abatement and control.

The reduction of waste loads and the alteration of waste characteristics is particularly applicable to industrial type wastes. Reductions and alterations can be brought about by 1) within-plant housekeeping, 2) use of non-polluting substances, 3) reuse of process materials and 4) development of by-products.

As shown in Table L-7(C), untreated industrial waste loads are projected to increase tremendously. A reduction in the amount of wastes generated obviously reduces the cost of treatment. In addition, altering the wastes to the form of saleable by-products may offer economic returns beyond the cost of treatment savings.

Source control, being universal in nature, plays a direct role in all levels of the Study's three basic objectives. That is: for Environmental Quality the reduced pollution load enhances the environment; for Economic Efficiency the relationship is obvious; and for Regional Development the interactions among these objectives provides the background for fulfilling this objective.

Programs of the nature mentioned above may be applicable to all industrial activities of the Subregion. In particular, the paper and chemical industries have made significant strides in reducing and altering their waste products. The food industry has already developed many by-products of processing and they, along with the aforementioned industries, have research and development programs in this field.

The reduction in volume of wastewater is applicable to both non-industrial and industrial situations. The underlying idea being: the reduction in volume of the vehicle (water) carrying the waste away from the source can significantly reduce the physical size of the facilities required to convey and treat the waste. Three methods by which these reductions can be accomplished are: 1) for non-industrial sources, educate people to use less water, 2) eliminate infiltration and other connections to sewers, and 3) for industry, separation of waters such as relatively clean cooling waters from process waters and reuse of process waters.

TREATMENT ALTERNATIVES

Wastewater from non-industrial and industrial sources generally contains large amounts of pollutional material which is biodegradable. Even with the implementation of all feasible source control measures, many wastes still must be treated to ensure adequate assimilation of such wastes by the receiving water without adverse effects upon any other water use. Projections of population and employment indicate organic waste loads will cause contravention of Water Quality Standards unless adequate treatment measures are provided.

A number of treatment methods and alternatives are available. In this study, secondary, tertiary and advanced waste treatment as well as flow regulation (specifically low flow augmentation) are considered.

In most areas, the water quality of the streams receiving discharges of secondary treated effluents will meet State and Federal Water Quality Standards until approximately 1980. In a few local areas additional levels of treatment will be required. In Planning Area 13 tertiary and advanced waste treatment practices will be required throughout the design period.

To meet anticipated increases in waste loads and the requirements of Water Quality Standards, approximately 1000 secondary wastewater treatment facilities will be needed in Subregion C by 1980. Presently Subregion C has 486 collection systems of which only 83 are of secondary or higher level of treatment.

Because the FWQA NAR Study Methodology did not allow for regionalization of larger facilities in densely populated areas or for collection systems in sparsely settled areas less than 1000 new plants may have to be built.

The ratio of population served by a given number of collection systems (see Table L-5(C)) to the total population served by the total number of systems is 1:2. The ratio of the numbers of systems involved is 1:4. This means that for Planning Areas 12 and 13 the number of needed facilities could be halved; which could reduce the number of facilities needed to approximately 600.

One other method of reducing this number is to allow for upgrading of present facilities. However, for the purposes of this study, complete replacement has been assumed to be needed every 20 years.

In Subregion C projections show that for the year 2000, about 900 wastewater treatment facilities will be needed and for 2020, 1700. The cost data for providing these facilities is given under Financial considerations on page 260.

As was mentioned earlier, supplements to secondary treatment will be needed throughout the study period. In addition, the need for tertiary or advanced waste treatment or low flow augmentation was investigated on a planning area basis. The procedure used in this determination is outlined in Chapter One. The comparison index for required water quality indications by Planning Area for the Target Years is shown below:

Planning Area	<u>1960</u>	<u>1980</u>	2000	2020
11	**	1.0	1.0	1.7
12	**	1.0	1.1	2.2
13	1.0	2.5	2.8	4.8

NOTE:

- ** or 1.0 Secondary treatment will suffice to meet water quality standards.
- 1.1 to 1.9 Further study will be needed by this date.
- 2.0 or greater Water quality standards will be contravened on a widespread planning area basis, thus necessitating the use of supplements to secondary treatment levels.

As noted in the Methodology and Rationale Section of Chapter One, Planning Area 13 is an exception to the general methodology. A synthetic load after 90 percent BOD removal was generated in Planning Area 13 since this number was generated from more detailed studies and enforcement activities. On the basis of these factors given above, the need for a higher level of treatment or low flow augmentation will be needed in Planning Area 13 throughout the design period and Planning Areas 11 and 12 will need either further study or higher levels of treatment or low flow augmentation after the year 2000.

However, flow regulation and low flow augmentation are not waste treatment methods; but are operational methods aimed at modifying or supplementing river flows to produce a minimum detrimental effect on the water quality of the receiving water.

In coastal planning areas such as Number 13, flow augmentation is not considered a feasible alternate to higher levels of waste treatment. Comprehensive basin-wide studies are needed to establish sound plans designed to optimize flow regulation.

Non-organic and toxic wastes must be considered individually and may have to be controlled by waste treatment processes other than secondary (biological) treatment processes. Any detailed discussion of this subject is beyond the scope of this study.

STUDY AND MANAGEMENT NEEDS

Various water quality and pollution control needs for Subregion C are evident as a result of work on this Appendix. From a water quality and water pollution control viewpoint, Type II (Comprehensive River Basin) studies should be conducted on a hydrologic basis for each planning area.

The recommendation to conduct studies in greater detail is based on three major predications: 1) to insure data accessability, 2) to develop adequate methodology to fill in gaps in data availability, and 3) to provide adequate pollution control surveillance. The lack of these three items soon became apparent as the NAR Study progressed. The FWQA-NAR Study Methodology was tailored to account for this lacking.

The following special studies and surveys are integral to providing realistic information for conducting water quality management programs.

Stream Surveillance Programs: Stream surveillance programs must be established as a part of water quality management programs designed to protect and enhance prime water usages as established by State authorities. Such programs should include a network of manual and automated sampling stations which permit the collection, evaluation and dissemination of water quality data, so as to present a clear picture of conditions in any section of the Subregion. These monitoring stations should be strategically situated near major wastewater sources so as to alert pollution control authorities to irresponsible or accidental discharge of harmful wastes and permit corrective actions to be taken immediately.

A surveillance program for New York State waters was established by the New York State Health Department in 1962. Since its inception, and aided by the Pure Waters Program Funds made available in 1966, the New York program has developed an elaborate network of manual and automated sampling stations.

Storage and Stream Flow Regulation: All water resource management programs should provide adequate flow and quality in the Subregion's waters. Comprehensive basin-wide studies are needed to establish sound plans designed to permit optimum beneficial uses of the streams. Such studies should determine the minimum flows required to provide adequate water supply, meet irrigation needs, effect

pollution control and allow recreational development. Following these determinations, plans should be developed to coordinate flow releases to meet these needs.

Operation and Maintenance: An adequate program of operation and maintenance at waste treatment plants is necessary to ensure that the existing and recommended new municipal and industrial treatment facilities will be effective in maintaining the designed waste treatment plant efficiency.

Adequate operation of treatment plants requires qualified resident personnel, proper laboratory control, and accurate record keeping. State, interstate and Federal agencies must provide programs aimed at ensuring these three factors are included at each plant. Because of the present limited supply of qualified operating personnel, there is an urgent need for both long and short term training courses in treatment plant operation. Such training should be continuous, and should lead to State licensing of operators. Federally sponsored and conducted training programs have been established to assist in the training of personnel. In order to ensure the successful implementation of any operation and maintenance program, the States must have a sufficient number of trained inspectors to periodically visit plants to review operation and laboratory control methods, and to provide technical assistance to plant personnel.

Municipal and Industrial Waste Inventory: A review of the available data on location, volumes and characteristics of existing municipal and industrial waste discharges within the Subregion indicates a lack of adequate information. There is a need to maintain the data current once an adequate base inventory has been established. The States should develop adequate records providing the latest information on all waste loads for use in planning, and determination of further pollution abatement needs.

Septic Tank Survey: Within Subregion C there are an estimated 1,500,000 persons who dispose of domestic wastes by individual septic tanks or cesspools. There are no adequate data indicating the pollutional effects of such systems. Studies should be conducted to determine the following:

- 1. Location of those areas with large numbers of septic tank systems.
- 2. Determination of the effects that such systems have on surface water and groundwater.
- 3. A plan for eliminating inadequate individual disposal systems by connection to existing or new municipal collection systems. Planning of such systems should be based on regional, inter-county or inter-municipal areas.

While the first two items could be accomplished by the Federal Water Quality Administration in cooperation with State and Federal agencies, the third item is the responsibility of State and local government. Existing Federal grant programs could be used to accelerate the planning, design, and construction of such regional collection systems.

Stormwater Overflow and Urban Runoff: Within Subregion C there are 92 non-industrial sewerage systems that have, at least in part, combined storm and sanitary sewage collection. There is a need to determine the quality and quantity of overflows from such systems, the extent to which such overflows degrade water quality, and similarly, the magnitude and effects of urban runoff flowing directly to the receiving waters.

Thermal Pollution: With the growth in the number and capacities of power plants and the continuing increase in industrial cooling water usage, pollution of the Subregion's waters by heat may become a critical problem. All existing sources of thermal pollution should be identified and determinations made of their effects on the aquatic environment. Plans for new facilities should make provisions, so that the wastewater discharged will meet thermal standards.

Boat Pollution: There is a need to determine the magnitude of the problems associated with the discharge of litter, sewage, and oil from the large numbers of boats in the Subregion. Investigations should include research to develop practical means of controlling this source, surveys to determine the need for adequate disposal facilities at marinas, and a determination of adequate legislation to control such pollution.

Agricultural Runoff: There are limited data available to indicate the extent of water pollution attributable to agricultural runoff. Since runoff from cultivated fields may convey fertilizers, herbicides and pesticides to the receiving waters, the potential dangers of such pollution require investigation. Such a study should include a determination of the types and amounts of agricultural chemicals being used, analytical data to measure the concentration of these chemicals in the receiving streams, and research into allowable concentrations and adequate control measures.

Aquatic Plants and Nutrients: Many areas within the Subregion are plagued by dense growths of aquatic weeds and algae to the extent that interference with beneficial water use results. There is a need for a survey to determine the extent and location of such plant growths, the determination of contributing causes and the development of programs to control the problem. Such control programs should include reduction in the quantities of nutrient materials discharged to the waters as well as means of physical removal of dense plant growths.

<u>Dredging</u>: Since extensive dredging activities are carried out in the Subregion, particularly in the Hudson River and New York Harbor, studies should be made to determine the extent such operations are affecting water quality. These investigations should result in the formulation of plans which will help coordinate dredging activities with water resource management and provide guidelines and practices to be followed by dredging operations.

Bottom Deposits: The extent to which banks of sludge and other substances have accumulated and are affecting the waters of the Subregion is not well known. A combination laboratory and field study is needed to determine the depth and rate of sludge build-up and the oxygen-uptake rate.

<u>Data Systems</u>: With the increasing tempo of data collection by a number of agencies at all levels of government, there is a need for an integrated system of handling water quality and water use data within the Subregion. Such a system, which might be based on the existing Federal Water Quality Administration STORET program, would make possible better interchange of knowledge and eliminate duplication of studies. Such an integrated system would further be of great value in permitting the application of such techniques as mathematical modelling and systems analysis in the development of overall water quality management programs.

Regional Cooperation: There is a need for water quality management programs to ensure that on-going and future programs consider not only the immediate locality but also the effects upon the Subregion as a whole. Studies recommending the creation of regional authorities must ensure that the needs of the smaller river basins are represented, weighed and/or integrated into the regional water management programs. Regional authorities may well be the operating mechanism best composed to promote inter-local cooperation between municipalities to coordinate planning among townships and counties, and to administer State and Federal programs.

Legal Framework: To ensure that adequate water pollution control programs are formulated and implemented, there is a need to evaluate existing legal mechanisms and institutional arrangements to determine their adequacy to deal with water quality problems on both a local and a regional basis. At the present time there is a lack of data on the adequacy of existing legal framework, as well as a lack of information on the interrelationships between various authorities and governmental agencies in dealing with the problem of resource management.

<u>Public Support</u>: In the final analysis, the residents of the Subregion must decide what use is to be made of their resources. Whether or not the decision that is reached is in the best interest of the majority of the residents depends on how well informed they

are of the facts concerning the environment and the consequences of their decision or their indecision.

The environment, in which and from which everyone derives existence, has been or is being destroyed by improper utilization. Past damage has been allowed to happen largely because of public apathy, lack of adequate pollution control programs, and the short-sighted desire for quick and easy monetary gain. Many of the environmental problems in Subregion C are the legacy of past industrialization. By the proper planning actions we must insure that similar charges cannot be leveled at our efforts.

In studies like the NAR Study, and in subsequent studies, every effort should be made to keep the public informed, to stimulate their interest and to enlist their support for water resource planning and management. For it will take informed and dedicated citizens and officials at all levels of government to adequately mobilize effective programs to meet the challenge of solving conflicting water use problems. Although technology may be available, and water also available, people must be made aware of and given the incentive to carry out the corrective measures. Answers must be given as to who is to pay and who is to benefit. An example of the type program needed to carry out this directive is New York State's Project "ABATES"; Ambassadors to Bring Action Through Environmental Study.

<u>Financial</u>: Estimates of the financial investment required for water quality control in Subregion C have been prepared for the design years 1980, 2000 and 2020 and are presented in Table L-9(C). The figures represent the capital investment that will be needed by each of these target years for treatment and other pollution control needs. Operating and maintenance costs for these facilities are not included.

The costs were based on the assumption that complete replacement would take place during each twenty-year period. The complete methodology used to estimate the cost of treatment, etc., is described in Chapter One of this Appendix.

The figures, given in Table L-9(C), are intended only to serve as indicators of the order of magnitude of financial investment needed in Subregion C for water quality control and are not intended to replace detailed estimates developed as the result of engineering studies for specific municipalities or industries.

RESEARCH AND DEVELOPMENT

Programs of research and development are needed in every aspect of water quality and pollution control, specifically those given in Section VII, "Pollution Control Methods - Source Control - Study and Management Needs" of this Appendix.

	Estimated Cost of	Estimated Addi- tional Cost of	
	Secondary _b /	Advanced Waste	đ/
Year	Treatment-	Treatment	Other Cost ^d
	PLANNING	G AREA NO. 11	
1980	\$ 90,000,000		\$ 53,000,000
2000	135,000,000		
2020	216,000,000		
	PLANNTNO	G AREA NO. 12	
1980	360,000,000		150,000,000
2000	640,000,000		
2020	1,150,000,000	\$190,000,000	
	PLANNING	G AREA NO. 13	
1980	1,160,000,000		2,000,000,000
2000	2,730,000,000	410,000,000	
2020	4,730,000,000	710,000,000	
	SIIRR	EGION TOTAL	
	BUBKI	DOZON TOTTLE	
1980	1,610,000,000		2,203,000,000
2000	3,505,000,000	410,000,000	
2020	6,096,000,000	900,000,000	

TABLE L-9(C) (Cont'd)

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL SUBREGION C

	Estimated	Estimated Addi-	
	Cost of	tional Cost of	
	Secondary _h ,	Advanced Waste	١ د
Year	Treatment ^D /	Treatment ^C /	Other Cost d/

- a/ For general purpose planning only. Based on 1960 dollars. Costs not to be applied to any individual situation.
- b/ Based on treating organic waste loads of both industrial and domestic origin.

 Treatment is considered to be 85% removal for the year 1980 and 90% for the years 2000 and 2020.
- c/ Treatment which would remove, in addition to 95%
 Biochemical Oxygen Demand and 98% suspended solids,
 up to 98% of nutrients and up to 95% of other materials
 not removed by conventional treatment methods.
- $\underline{d}/$ These costs are, where known, estimates for combined sewer overflows control.

To provide new and improved methods of pollution control, the FWQA research program gives grants to help finance projects which will demonstrate methods for advanced waste treatment, provides new or improved methods for joint treatment of municipal and industrial wastes, and establishes new or improved methods for controlling or preventing pollution caused by discharges from combined sewer systems. Grant funds are also available to help find practical solutions for the prevention of pollution of waters by industry, mining and pollution associated with natural causes.

Similar research and development activities are conducted as a part of the Pure Waters Program of the State of New York. Practically all of this effort, both Federal and State, is directed towards finding technical solutions that can be applied as quickly as possible in dealing with known problems. This program has to be expanded to provide management tools and policies to deal with all problems.

VIII. POLLUTION CONTROL PROGRESS

INTERNATIONAL

The International Joint Commission (Canada - United States) has jurisdiction over portions of the Champlain Basin. In the past, their activity has been limited to feasibility studies of further navigational improvement of the International Champlain Waterway (the shortest water route between New York City and Quebec).

INTERSTATE

A quasi-official interstate body, INCOCHAMP (Interstate Commission on the Champlain Basin) has operated in the past to bring together resource management personnel from the States of New York and Vermont to plan orderly development of the land and water resources of the Champlain Basin. Although no official compact was created to authorize this agency, both States have had tentative statutory approval to create the Lake Champlain Basin Compact. Once established, this Compact will serve as a formal planning authority charged with the responsibility of planning land and water resources within the Champlain Basin including such activities as water pollution control.

In the New York City area, the Interstate Sanitation Commission (ISC) was created in 1936 for the purpose of enforcing the provisions of the Tri-State Compact for Water Pollution Abatement. The States of Connecticut, New Jersey and New York each agreed to appropriate funds for the operating expenses of the Commission and pledged cooperation in the abatement of pollution in the tidal and coastal waters of the district. Due to the recent State pollution control programs, the requirements of ISC are now surpassed by the States' water quality standards for the same areas. The ISC has been instrumental in arriving at practical solutions to the problems of the New York City area.

A more recent addition to the quasi-official bodies is the Hudson River Valley Commission. It was established in 1966 by the New York State Legislature as a permanent State agency to coordinate planning along the Hudson River and to encourage the balanced development of land and resources. The Commission reviews proposed projects which would destroy or substantially impair significant historic or recreational resources or bring about a major change in the appearance or use of the water in the Hudson River or the surrounding land.

STATE

The States of New York and Vermont have had established water resource development programs to protect the orderly development of resources. Both States have established interstate water quality standards and implementation plans for achieving these standards. New York has also completed classification of its intrastate waters. In 1965, New York State initiated a six year comprehensive program for the elimination of water pollution in the State. It included and passed a \$1.7 million bond issue to provide the means to accomplish the necessary abatement.

FEDERAL

The Water Quality Act of 1965, as amended, contains authorization for increased Federal involvement in efforts to eliminate pollution and enhance water quality in the Nation's waters. The Act also broadened the mechanism through which the Federal government would share in the cost of financing new waste treatment facilities. As of July 1969 some 173 projects in Subregion C are either under construction or completed. Some \$440 million are being expended on these projects, of which some \$48 million is from Federal funds, representing about 50 percent of the funds which have been allocated to the entire State of New York.

In conjunction with the funding of pollution abatement facilities, the Federal government also is authorized to, when requested by a State, hold an enforcement conference to ascertain the necessary abatement measures. A compliance schedule is made a part of such conferences. In the past 10 years the following water bodies and their tributaries in Subregion C have been the subject of enforcement conferences: Lake Champlain, Hudson River, and Great South Bay - Moriches Bay.

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY

APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 5

SUBREGION D

ENVIRONMENTAL PROTECTION AGENCY WATER PROGRAMS OFFICE May 1972

CHAPTER 5

SUBREGION D

I. SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Chapter 5 is a report on Water Quality and Pollution in Subregion D of the North Atlantic Regional Water Resources (NAR) Study Area.

This report is intended to give broad base planners an insight into the problems, needs, demands and interrelationships associated with water quality and water pollution in Subregion D. The Summary Findings, Conclusions and Recommendations given in this section can provide a program of requirement patterns for water resources management from a water quality viewpoint.

Findings, Conclusions and Recommendations pertain specifically and generally to Subregion D. No attempt was made here to discuss inter-subregion perceptional categories.

SUMMARY FINDINGS

- 1. Subregion D is located near the middle of the NAR Study Area and covers one-tenth of the entire Region's land area, some 17,800 square miles of land and 586 square miles of inland surface waters. The Subregion is comprised of the State of New Jersey plus counties in the States of New York, Pennsylvania and Delaware which drain to the Delaware River.
- 2. The three major drainage systems in Subregion D are: the Northeastern New Jersey Streams, the Delaware River Basin and the Atlantic Coastal Basins. Hydrologically, these systems have a drainage area of about 16900 square miles with 586 square miles of inland surface waters.
- 3. Subregion D had a 1960 population of 11,124,000 which translates into an overall population density of 625 persons per square mile. On a Planning Area basis, the population densities range from 329 persons per square mile in Planning Area 16, to 468 in Planning Area 15, to a high of 1885 in Planning Area 14.
- 4. Population projections to 2020 for Subregion D indicate that 21,122,000 persons will cause the overall population density to increase to about 1360. This will be almost twice the density of Subregion C in 2020.
- 5. The economy of Subregion D is diversified. The presence of 11,124,000 people in the Subregion, demands an orientation toward service industries but the Subregion has also a large dependence on

water-using industries. This Subregion ranks first in the NAR in both total manufacturing employment and employment in the six major water-using industries, and second in total population, total employment, and per capita personal income.

- 6. Projections show that Subregion D will maintain its relative economic position through the year 2020.
- 7. The waters of Subregion D are presently being used for various and, in many instances, conflicting purposes. The uses of these waters can generally be described within the following categories: Municipal and Industrial Water Supply, Shellfish Propagation, Recreation, Commercial Fishing, Commercial Navigation, Power Generation, Irrigation and Other. Of these uses, Municipal and Industrial Water Supply accounted for 4825 MGD of water used in 1965. By 2020, the Municipal and Industrial Water Supply Demand is projected to increase to 12487 MGD.
- 8. The two most important sections of this Subregion D, Chapter 5 are Section VI, "Present and Future Water Quality Problems" and Section VII, "Pollution Control Methods."
 - A. Source control and treatment are the two most significant pollution control methods available to Subregion D.
 - B. There are many study and management needs for Subregion D. Type II study recommendations for the Delaware Basin should be implemented.
 - C. Research and development, public support and financial assistance are especially needed in Subregion D.
 - D. The estimated cost of providing secondary treatment levels to all of Subregion D are: for 1980 \$1.9 Billion, for 2000 \$6.2 Billion and for 2020 \$13.1 Billion.
- 9. Waste sources within Subregion D are varied and numerous. The most significant are non-industrial and industrial activities, combined sewers, rural and urban runoff, septic tanks and cesspools, thermal discharges, recreational and commercial navigation, ocean disposal of wastes and construction activities.
- 10. Non-industrial and Industrial sources of organic waste loads presently discharge 14 million P.E. of BOD to the waters of the Subregion. Non-industrial sources account for about 25 percent of this total. The remaining 75 percent consists of approximately equal amounts from the textile, paper, chemical and petroleum industries.
- 11. Presently in Subregion D, Planning Area 14 receives the largest discharged waste load. However, after the year 2000, Planning Area 15 waste loads are projected to be double those of Planning Area 14.

- 12. Future untreated organic waste loads will increase to 73 million P.E.'s in 1980, 155 million in 2000 and 322 million in 2020. With secondary treatment levels, these loads will be reduced to 11 million P.E.'s in 1980, 16 million in 2000 and 32 million in 2020 which would then be discharged to the waters of the Subregion. By the year 2020, industrial waste loads are projected to account for over 90 percent of the total organic waste load.
- 13. Inorganic waste sources exist in Subregion D though they are usually over-shadowed by the volume of non-industrial and industrial types of organic waste loadings. An overview of the agricultural sources, including amounts of inorganic sediment, can be obtained from consulting the attachment from the Soil Conservation Service to Chapter One of this Appendix and consulting Appendices, H, I, J, K and Q of the NAR Study Report.
- 14. The only notable acid mine drainage in Subregion D occurs in about 200 miles of streams in Planning Area 15. It is expected that a large portion of the acid mine drainage will be treated through the design period.
- 15. Stormwater and municipal wastes are presently collected, transported and discharged through some 30 combined sewer systems within Subregion D. These systems serve an estimated population of 4,410,000 persons or about 40 percent of the Subregion's entire sewered population.
- 16. Numerous Pollution Control Methods are in use in Subregion D. There are, however, serious gaps in data availability, adequate methodology and pollution control surveillance for Subregion D.
- 17. Progress in Pollution Control in Subregion D is noteworthy particularly because of the existence of the Interstate Sanitation Commission and the Delaware River Basin Commission.

CONCLUSIONS

- 1. In Subregion D the major water bodies in the vicinity of population and industrial centers are seriously degraded by pollution.
- 2. All major water bodies in Subregion D are currently receiving treated or untreated non-industrial and industrial waste loadings.
- 3. Often the uses of the Subregion's waters are hampered and even eliminated by this pollution.
- 4. Through 2020, Subregion D has a projected population of 21,122,000 which indicates that it will maintain an extremely high

population density. This means that Subregion D will become progressively more urban in character and types of problems.

- 5. The enormity of the projected increase in discharged waste loads requires immediate implementation of devices and procedures to eliminate this threat to the environment.
- 6. As a result of the implementation of water quality standards, a general trend toward increased use or multiple use of the surface waters of Subregion D can be expected.
- 7. The quality of the Subregion's waters will have a direct bearing on the success of any management requirements necessary to meet the NAR Study's three basic objectives of Environmental Quality, Economic Efficiency and Regional Development.
- 8. Organic pollution from both non-industrial and industrial sources is the most significant degrader of water quality in the Subregion.
- 9. Combined sewer overflows and inorganic pollutants are the next most serious problems in Subregion D.
- 10. Although Progress in Pollution Control is noteworthy in Subregion D, much more time, manpower, money, laws, enforcement actions, education and institutional arrangements are needed before water of an adequate quality can be ensured so as to meet the demands and needs of this Subregion.

RECOMMENDATIONS

- 1. Since serious gaps in actual data relevant to water quality and pollution in Subregion D are now apparent, an effort should be made to collect this data.
- 2. Methodology and Rationale, as devised for this Study, should be further developed and refined. This should include factors to determine benefits, waste loadings and effects of regionalization.
- 3. Benefits and costs, and who is to benefit, and who is to pay for providing adequate water quality to Subregion D, should be determined.
- 4. Water Quality Standards should be implemented, enforced and updated in-line with revised desires of society.
- 5. Research and Development programs presently underway should be expedited and expanded especially in programs for combined sewer overflows control and in development of economical methods of advanced waste treatment.

- 6. Research and Development programs should be implemented for determining multiple feasible and economical methods of source control, collection systems and "other" uses of wastewater, such as ground water recharge and irrigation.
- 7. The Study and Management Needs described in Section VII, especially conducting Type II Studies by the year 2000 for all three Planning Areas, should be completed.
- 8. Involvement and education of people in environmental study and control is necessary for pollution control.
- 9. It is recommended that a full-scale study be made of the powers, responsibilities and other factors involved in multi-community, multi-level government service agencies, so that administrative means be developed to implement the recommendations of this report.

FIGURE D-1

MAP OF

SUBREGION D

LOCATION AND BOUNDARIES

(Located in back of book)

TABLE L-1(D)

SUBREGION D - PLANNING AREAS

Planning	Grouping of Whole	Complete and Partial Major
Area	Counties in the	River Basins Within the
Number	Planning Area	Planning Area
14	Bergen, N.J. Essex, N.J. Hudson, N.J. Hunterdon, N.J. Middlesex, N.J. Morris, N.J. Passaic, N.J. Somerset, N.J. Union, N.J.	Passaic River, Raritan River and Other Northern New Jersey Streams Drain- ing to Newark-Raritan Bays Complex
15	Delaware, N.Y. Sullivan, N. Y. Burlington, N.J. Camden, N.J. Cumberland, N.J. Gloucester, N.J. Mercer, N.J. Salem, N.J. Sussex, N.J. Warren, N.J. Berks, Pa. Bucks, Pa. Carbon, Pa. Chester, Pa. Delaware, Pa. Lehigh, Pa. Monroe, Pa. Montgomery, Pa. Northampton, Pa. Philadelphia, Pa. Pike, Pa. Schuylkill, Pa. Wayne, Pa. Kent, Del. New Castle, Del.	Delaware River and Delaware Bay
16	Atlantic, N.J. Cape May, N.J. Monmouth, N.J. Ocean, N.J.	Atlantic Coastal Area from Sandy Hook to Cape May, New Jersey

TABLE L-2(D)

SUBREGION D - MAJOR RIVERS AND TRIBUTARIES

Water Body	Length (Miles)	Drainage Area (square miles)
	PLANNING AREA NO. 14	
NORTHEASTERN NEW JERSEY STREAMS		
Hackensack River Passaic River Elizabeth River Raritan River	50 86 12 81	197 935 23 1,125
	PLANNING AREA NO. 15	
DELAWARE BASIN		
Delaware River East Br. Delaware River West Br. Delaware River Pequest River Lehigh River	315 75 90 34 80	12,765 838 648 158 1,364
Musconetcong River Assunpink Creek Rancocas Creek Perkiomen Creek Schuylkill River	45 17 75 93	158 89 335 - 1,909
Brandywine Creek Paulins Kill Pohatcong Creek	32 42 30	329 179 -
	PLANNING AREA NO. 16	
ATLANTIC COASTAL		
Swimming River Shark River Manasquan River Metedeconk River Toms River	20 26 33	- - - 111 196
Mullica River Batsto Creek Oswego Creek Great Egg Harbor River	45 19 21 52	15 72 - -

II. DESCRIPTION OF SUBRECTON

LOCATION AND BOUNDARIES

Subregion D is located near the middle of the North Atlantic Region and covers about 10 percent of the entire Region's land area, some 17800 square miles of land and 586 square miles of inland surface waters. The Subregion is composed primarily of the entire Delaware River Basin and the smaller New Jersey streams draining to the Atlantic Ocean. The geographical location and boundaries of the Subregion are shown in Figure D-1.

Subregion D was divided into three water resource Planning Areas; each Planning Area consists of one or more whole counties. Table L-1(D) lists the Planning Areas, the counties, and the whole or partial river basins in each planning area.

PHYSICAL FEATURES

Hydrology: Subregion D is composed of three major drainage systems: the Northeastern New Jersey Streams, the Delaware River Basin, and the Atlantic Coastal Basins. The location of each of these systems is shown in Figure D-1. Hydrologically, these systems have a drainage area of about 16900 square miles and an additional 586 square miles of inland and estuarine waters. The lengths and drainage areas of the major rivers and tributaries is presented in Table L-2(D). Detailed data are presented in Appendix C, "Climate, Meteorology, and Hydrology," of the NAR Study Report.

General Geology: Subregion D contains portions of two major physiographic subdivisions: the Atlantic Plain and the Appalachian Highlands. The Atlantic Plain is often referred to as the Coastal Plain, and in New Jersey is divided into an "Inner" and "Outer" Coastal Plain. The Appalachian Highlands are divided into four provinces: Piedmont, New England, Valley and Ridge, and the Appalachian Plateau.

Because the geology of these areas is so diverse, no detailed analysis will be given here. For specific information on the actual geology by location consult Appendix D, "Geology and Groundwater," of the NAR Study Report.

CLIMATE

Typical Temperate Zone seasonal fluctuations occur in Subregion D. The inland mountain sections have seasonal temperature variations of about 50°F . The winters are cold with annual minimum-maximum temperatures averaging 5°F to 30°F for January and the summers are moderate with July annual minimum-maximum temperatures averaging 50°F to 85°F .

The average annual precipitation in the coastal areas is about 40 inches while in the northern portion of Subregion D 60 inches is reported.

For a more detailed location analysis of climate in Subregion D, consult Appendix C, "Climate, Meteorology and Hydrology," of the NAR Study Report.

III. ECONOMY

SELECTED ECONOMIC MEASURES

Subregion D encompasses 38 counties, including nine SMSA's and eight urban centers.

Subregion D had a 1960 population of 11,124,000 which is translated into an overall population density of 625 persons per square mile. Significant variation occurs on the Planning Area level of comparison however, from 329 persons per square mile in Area 16 to 468 in Area 15 to a high of 1885 in Area 14.

Population projections to 2020 for Subregion D indicate that 21,112,000 persons will cause the overall population density to increase to about 1,360 people. This will be almost twice the density in Subregion C in 2020. Consequently, Subregion D will become increasingly urban in character and types of problems.

Comparison with the other five NAR Subregions shows that Subregion D's economic position will remain relatively stable through the year 2020. The Subregion now ranks first in both total manufacturing employment and employment in the six major water-using industries, and second in total population, total employment, and per capita personal income. The above discussion illustrates the fact that the Subregion's large populations and industrial development will cause disposal of these types of wastes to be of primary concern when comparing types of problems in the six NAR Subregions.

Detailed economic data on Subregion D are presented in Appendix B, "Economic Base," of the NAR Study Report. Selected summary data are presented in Table L-3(D).

TABLE L-3(D)

SUBREGION D - SELECTED ECONOMIC MEASURES

ECONOMIC MEASURES	<u>1960</u>	1980	2000	2020
Population	11,124,000	13,818,000	17,166,000	21,122,000
Total Personal Income (\$000) (1958 Dollars)	28,105,300	63,932,800	134,990,400	282,956,600
Per Capita Income <u>a</u> /	2,546	4,627	7,864	13,396
Total Employment	4,364,700	5,613,300	6,939,600	8,448,400
Agriculture + Forestry + Fisheries	72,500	52,000	38,900	28,500
Mining	12,800	4,700	3,600	2,900
Total Manufacturing	1,627,500	1,749,400	1,859,600	2,001,700
Six Major Water-using Industries Total	581,600	610,300	662,600	742,700
20 Food and Kindred Products 22 Textile Mill Products 26 Paper and Allied Products 28 Chemicals and Allied Products 29 Petroleum Refining 33 Primary Metals	135,100 87,700 51,200 157,600 42,300 107,700	127,100 60,600 63,200 214,600 24,800 120,000	119,000 43,300 73,100 282,400 17,600 127,200	112,700 31,800 84,600 365,500 12,600 135,500
All Other Manufacturing Employment	1,045,900	1,139,100	1,197,000	1,259,000
Armed Forces (number)	73,100	66,600	66,600	66,600
All Other Employment Categories	2,578,800	3,740,600	4,970,900	6,348,700

a/ Based upon 1959 population and personal income reported in 1960 Decennial U.S. Census.

Source: North Atlantic Regional Water Resources Study, Appendix B, Economic Base,
Prepared by Office of Business Economics, Regional Economics Division, U.S. Department of Commerce.

IV. PRESENT AND FUTURE WATER USES

GENERAL

The waters of Subregion D are presently being used for a variety of purposes. The uses of these waters can generally be described within the following categories:

Municipal and industrial water supply
Shellfish propagation
Recreation
Commercial fishing
Commercial navigation
Power generation
Irrigation
Other

The extent to which these waters can be utilized will depend on their future water quality. The quality will have a direct bearing on the success of any management requirements necessary to meet the NAR Study's three basic objectives of Environmental Quality, Economic Efficiency and Regional Development.

Information on the existing and anticipated uses of these waters, is contained in Table L-4(D). With regard to usage, little change is expected in the future.

In order to give some insight into the magnitude and diversity of present and future demands on the waters of Subregion D, the following information is provided.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY 1/

In 1965, the total municipal and industrial (M&I) water use was 4825 million gallons per day (MGD). Municipal demand, which includes that portion of industry served by municipal systems, amounted to 1577 MGD. The remaining 3248 MGD was self-supplied by industries from sources other than municipal systems.

Within Subregion D, municipal and privately owned water supply systems serve approximately 10.8 million persons, or 97 percent of the total subregion population.

The major industrial water users in Subregion D are the food processing, textile, paper, chemical, and petroleum industries. They account for 96 percent of the industrial water use. This large amount of water and its organic waste load of 10,300,000 population equivalents (P.E.'s) plus many toxic agents, has a substantial impact on water quality in Subregion D.

^{1/} Source: NAR Study Report, Appendix R, "Present and Future Water Supply."

TABLE L-4(D) $\label{eq:condition} \text{SUBREGION D - PRESENT AND FUTURE WATER USE} \frac{1}{2} / \frac{2}{2} / \frac{1}{2}$

Water Body		Water Supply	Shell- fishing	Bathing	Fish	Agric., Ind., Navig. & Other
	Legend	x = 1	resent Use	0	= Future Use	
		PLANN	IING AREA NO	. 14		
NORTHEASTERN NEW JERSEY STREAMS						
Newark Bay						хо
Hackensack River		хo		xo	xo	xo
Passaic River		хo		xo	xo	хо
Arthur Kill						xo
Elizabeth River					xo	хo
Kill Van Kull						xo
Raritan Bay			xo	xo	xo	хо
Raritan River		xo		xo	xo	хo
		PLAN	NING AREA NO	<u>. 15</u>		
DELAWARE RIVER BASIN						
Delaware River		хo	xo	xo	xo	xo
Paulins Kill		xo		xo	xo	xo
Pequest River		xo		xo	xo	xo
Lehigh River		xo		xo	xo	xo
Pohatcong Creek				xo	xo	xo
Musconetcong River		xo		хo	xo	xo
Schuylkill River		хo		хo	xo	xo
Brandywine Creek		xo		xo	xo	xo

Water Body		Water Supply	Shell- fishing	Bathing	Fish	Agric., Ind., Navig. & Other
	Legend	x = F	resent Use	0 =	Future Use	
		PLANN	IING AREA NO.	. 16		
ATLANTIC COASTAL						
Swimming River		хo		xo	xo	xo
Shark River				xo	xo	xo
Manasquan River				xo	xo	xo
Metedeconk River				xo	xo	xo
Toms River		хo		xo	xo	xo
Mullica River		хo	xo	xo	xo	xo
Great Egg Harbor Riv	er	xo	хo	xo	xo	xo

¹/ Water uses are for the stream in general and not for any specific reach.

 $[\]underline{2}/$ Future uses are those called for in the water quality standards.

Rapidly expanding residential and industrial development, which is now occurring in Subregion D, is expected to continue at an even more accelerated rate throughout the design period. This will require more extensive use of water. Estimates indicate that the total M&I water needs will be 4233 MGD in 1980; 7419 MGD in 2000; and 12,487 MGD in 2020. The major increases in water use will probably occur as development fills in the areas between the present centers of both population and industry.

RECREATION

<u>Bathing</u>¹: The entire Subregion offers numerous beach and bathing opportunities, which accounts for the great popularity of this water-oriented sport activity. Bathing facilities can be found along the many natural and man-made lakes, ponds and pools scattered throughout the mountains and lowlands, and along the barrier beaches of the Atlantic Ocean. These include municipal as well as privately owned facilities. The publicly owned beaches, together with facilities privately owned but available for public use, exceed 3000 acres, and are capable of serving 4.5 million people daily.

Based on projected recreational activity, bathing will increase about threefold by 2020 and require the development of approximately 2000 acres in new beach areas. If EQ standards are utilized in lieu of RD standards, a need of almost 5500 acres becomes evident.

Boating 1/: Recreational boating is widespread throughout the Subregion and is becoming an increasingly popular pastime. The large number of marinas and yacht clubs are indicative of the extensive use of these waters for pleasure boating. There are at least 335 private, and five public marinas and yacht clubs in the Subregion.

Estimates indicate that boating in Subregion D will increase throughout the design period; about 64 percent over the present by 2000 and 159 percent by 2020. The development of marinas and associated facilities to meet these recreational needs will result in greater localized pollution problems unless closer regulatory and surveillance activity is provided.

Sport Fishing²: Fresh water fishing is growing in popularity each year throughout most of the Subregion, although it is understandably limited in the densely populated Metropolitan areas. The increased pollution load to these waters has had a significant adverse effect on fish species; in many sectors, fish and aquatic life are non-existent.

^{1/} Source: NAR Study Report, Appendix M, "Recreation."
2/ Source: NAR Study Report, Appendix O, "Fish and Wildlife."

However, less populous areas do have wide variety of fishing opportunities. There is an abundance of both cold and warm water habitats, including many high quality trout streams. The bulk of the fishing in the headwaters areas is done by vacationers and tourists.

Salt water sport fishing is concentrated in Planning Area 16 and the southern quarter of 15. A great variety of species are present during the year and all types of tackle and equipment are utilized. It is expected that salt-water fishing activity will increase nearly 50 percent by the year 2020 to 13.5 million man-days.

Subregion D waters will be subjected to increased usage by fishermen in the future. It is estimated that for Subregion D as a whole, 21.5 million man-days will be devoted to fishing in 1980. This participation is predicted to rise to 27.0 and 33.4 million man-days in 2000 and 2020, respectively.

Wildlife and Waterfowl!: The presence of wildlife and water-fowl varies considerably in Subregion D. Big game hunting, i.e., whitetailed deer, is excellent in the northern portion of the Delaware Basin. Small game hunting is good in most areas, but is also considered excellent in the northern portion. The coastal and tidal areas of the Subregion offer exceptionally good waterfowl hunting.

Pollution has had a particularly adverse effect on waterfowl. The discharge of domestic and industrial wastes coupled with agricultural drainage, dredging, and the filling of marshlands to meet expanding residential and commercial needs has made a dramatic impact on the waterfowl habitat.

Based on the number of million man-user-days presumed to be devoted to hunting, Subregion D can expect an increase for this water-oriented sport in each of the design years. Wildlife hunting will increase from 9.3 million man-days in 1960 to 10.6 in 1980, 13.2 in 2000 and 16.3 million man-days in 2020.

Improvements in the water quality conditions, and the preservation and enhancement of desirable natural land areas can be positive steps toward removing the significant restrictions placed on this recreational resource by pollution.

COMMERCIAL FISHING2/

The commercial fin and shellfish industry has been present in the coastal and tidal portions of Subregion D for many years. However, a combination of overfishing and man-made environmental changes,

^{1/} Source: NAR Study Report, Appendix 0, "Fish and Wildlife."
2/ See NAR Study Report, Appendix 0, "Fish and Wildlife," for
 detailed monetary values.

including those resulting from pollution, has reduced the value of the waters for this use. The shellfish industry has been drastically changed in the last 15 years due to the MSX oyster virus and increasing pollution levels. Harvests of oysters and other shellfish previously taken from the estuarine waters have dropped significantly while a great increase has been noted in the surf clam harvest. A sharp rise has also been noted in the Atlantic Menhaden fishery, due primarily to recent changes in technology and processing methods.

Future use of the waters of Subregion D for commercial fishing is not quantifiable at this time; however, the use will increase in years to come. The pressures on the resource by competing uses are also expected to mount sharply. Many of the presently closed shell-fish beds can be reactivated when water pollution control facilities reduce the amount of pollutants entering these waters.

COMMERCIAL NAVIGATION1/

Commercial shipping in Subregion D is primarily centered around the Planning Area 15 ports of Philadelphia, Trenton and Wilmington. In the Subregion, the 1960 total of 150.3 million tons shipped was composed of 33 million tons from Planning Area 14, 117 million tons from 15, and 0.3 million tons from 16.

Commercial navigation will increase in Subregion D during all design years; estimates indicate that the annual tonnage will be 229.5 million in 1980, 40.8 million in 2000, and 727.3 million in 2020.

POWER GENERATION2/

<u>Hydropower</u>: In 1968, there were three individual hydroelectric power plants in Subregion D with a total installed hydroelectric capacity of 400 MW.

It is not anticipated that there will be any demand for hydroelectric power in Planning Area 16.

In Planning Areas 14 and 15, however, hydropower requirements are expected to increase through all design years, totalling 4410 MW in 1980, 13910 MW in 2000, and 33910 MW in 2020.

^{1/} Source: NAR Study Report, Appendix K, "Navigation."

^{2/} Source: NAR Study Report, Appendix P, "Power."

Steam: As of 1968, there were at least 28 fossil fuel steam electric generating plants with an installed capacity of 11904 MW of electrical power located in Subregion D.

At present, the number and capacities of privately owned steam generating plants, such as industrial installations, is unknown.

Two nuclear generating stations, one in Planning Area 15 and one in 16, are currently under development.

Thermal pollution resulting from both public utility power plant sources and industrial activity can be expected to increase with the continued demographic and industrial growth of the Subregion. Electrical energy produced by steam driven turbines is expected to multiply 25 times by 2020. It is estimated that the total steam electric capacities will be 25000 MW in 1980, 96300 MW in 2000 and 280,000 MW in 2020. Facilities to meet these needs will probably be constructed in all Planning areas of Subregion D.

IRRIGATION1/

In Subregion D, the majority of the 83,000 acre-feet (AF) used in 1960 on crop land was in Planning Area 15 (57,000 AF). Projections indicate that the same ratios of usage will hold through the design years. A total of 241,000 AF will be needed in 1980, 306,000 AF in 2000 and 335,000 AF in 2020. This quadrupling of future irrigation water requirements should be seriously considered in any comprehensive river basin planning in Subregion D.

OTHER

Presently, a tremendous amount of wastewater and semi-solid wastes is dumped into the Subregion's fresh and salt waters for disposal. This practice is projected to be controlled so that other legitimate water uses are not restricted by these practices. Further information on this practice is given in Section 5 of this Appendix.

There are two other uses of the Subregion's waters which must be considered: farming of sea food and the mining of sand and gravel. However, information on these is still in the developmental stage. Further information on these water uses will be contained in several of the NAR Study Report Appendices, primarily G, H, O, T and U.

^{1/} Source: NAR Study Report, Appendix I, "Irrigation."

V. PRESENT AND FUTURE WASTE SOURCES

GENERAL

The wastewaters being discharged to the waters of Subregion D are large in volume and strength. Untreated, partially treated, and treated waste from non-industrial and industrial sources, amounting to 14 million P.E. of BOD, is presently being discharged to the waters of Subregion D.

Industrial discharges, consisting of wastes from all the major water-using industries, contribute 10,310,000 P.E.'s or nearly 75 percent of the total load. The textile, paper, chemical and petroleum industries each discharge about 20 percent of the total load.

Future untreated organic waste loads will increase to 73 million P.E.'s in 1980, 155 million in 2000 and 322 million in 2020. After secondary treatment these loads will be reduced to 11 million P.E.'s in 1980, 16 million in 2000 and 32 million in 2020. By the year 2020, industrial wastes will account for 93 percent of the total organic waste load.

Tables L-5(D), L-6(D) and L-7(D) summarize for Subregion D the present and future organic waste loadings generated and discharged to streams.

Other types of waste sources, both organic and inorganic, exist in Subregion D though they are masked by the volume of non-industrial and industrial waste loadings. A more extensive analysis of all these sources is presented in the following paragraphs.

NON-INDUSTRIAL AND INDUSTRIAL

Non-Industrial Waste Loads: Presently 494 identified municipal, institutional and Federal sources discharge wastes to the waters of Subregion D, exerting a biochemical oxygen demand of approximately 3,857,000 P.E.'s. Selected information concerning these sources is summarized in Table L-5(D).

In 1960, approximately 90 percent of the total Subregion normal population was served by wastewater collection systems. The summer population influx in Planning Area 16, which more than doubles the resident population, accounts for about 10 percent of the population served. About 2 percent of the Subregion's non-industrial waste was discharged to receiving waters untreated, 50 percent with primary treatment and 30 percent with secondary treatment.

		D	EGRE	E O	F TRE	ATMEN		Systems	Systems	Combine
Planning Area	Sub- Total	U <u>nknown</u>	None	Pri- mary	Inter- mediate	Second- ary	Adv. Waste Treat.	Over- loaded; Outdated	Not Chlor- inating	Storm- Sewer Systems
14 Number of Systems	69	_	14	32	_	23	_	20	24	8
Pop. Served (000)	3,700	<u>-</u>	93	3,069		538	_	1,948	1,570	1,759
Waste Load Disch. Calc. P.E. (000)	2,169		93	1,995		81				
15 Number of Systems	295	_	44	39	_	212				19
Pop. Served (000)	5,170	99	113	2,142		3,291				2,600
Waste Loads Disch.	•									
Calc. P.E. (000)	900		113	1,392		494				
1 <u>6</u>										
Number of Systems	130	41	_	48		20	_	27	1	2 51
Pop. Served (000) Waste Load Disch.	1,451	105		1,148	57	127		407	175	21
Calc. P.E. (000)	788			746	23	19				
Subregion Total	4									
Number of Systems	494	41	58	119	20	255	_	47	25	29
Pop. Served (000) Waste Load Disch.	10,876	204	206	6,359		3,956	-	2,355	1,745	4,410
Calc. P.E. (000)	3,857		206	4,133	23	594				

 $[\]underline{1}/$ Includes waste loads from municipalities, institutions and Federal installations.

TABLE L-6(D) SUBREGION D - ESTIMATED PRESENT INDUSTRIAL WASTES

SUMMARY

	2 D	igit SIC Group	Waste Load Before Treat.1/ (Est. P.E.)	Number of Known Sources	W None		UACY TREAT Complete	O F M E N T Unknown	Discharged Waste Load2/ (Est. P.E.)	Possible Pollutants Other Than Organic Load
	20	Food Water Use MGD	3,480,000	8 49.40	5 47.4	2.05		1 1.95	1,800,000	SS ^{3/} ,Grease,Oil, Disease-Bacteria
	22	Textiles Water Use MGD	4,230,000	1 .55				1 .55	900,000	SS, Color
Ę	26	Paper Water Use MGD	6,100,000	11 410.48	1 4.3	7 338.95		3 17.2	2,650,000	SS, Color, pH
L-290	28	Chemicals Water Use MGD	5,250,000	55 444.53	15 78.06	30 333.00	7 31.67	3 1.8	2,710,000	SS, Color, Oil, pH, Grease, Toxic Materials
	29	Petroleum Water Use MGD	4,190,000	10 629.51	1 1	9 628.51			1,960,000	SS, Oil, Grease
	33	Primary Metals Water Use MGD	900,000	15 393.48	6 57.29	6 80.84	2 254.85	1 .50	290,000	Toxic Metals, pH, SS, Oil
	Sub	region Total Water Use MGD	24,150,000	136 <u>4</u> / 2,296.61	28 188.05	54 1,431.38	9 286.52	9 22.00	10,310,000	

 $[\]underline{1}/$ Calculated waste load generated by entire 2 digit SIC group activity.

^{2/} Derived from waste load before treatment, adequacy of treatment and published data.
3/ SS - Suspended solids.
4/ Total includes undetailed breakdown of Planning Area No. 16 SIC groupings.

 $[\]underline{1}$ / Calculated waste load generated by entire 2 digit SIC group activity.

 $[\]overline{2}$ / Derived from waste load before treatment and adequacy of treatment.

^{3/} SS - Suspended solids.

TABLE L-6(D) SUBREGION D - ESTIMATED PRESENT INDUSTRIAL WASTES PLANNING AREA NO. 15

2 D	Digit SIC Group	Waste Load Before Treat.1/ (Est. P.E.)	Number of Known Sources	W None		U A C Y T R E A T Complete	O F M E N T Unknown	Discharged Waste Load2/ (Est. P.E.)	Possible Pollutants Other Than Organic Load
20	Food Water Use MGD	1,680,000	6 49.35	5 47.40			1 1.95	412,000	SS ^{3/} ,Grease,Oil, Disease-Bacteria
22	Textiles Water Use MGD	2,440,000	1 .55				1 •55	·	SS, Color
26	Paper Water Use MGD	2,830,000	6 382.98		6 382.98			567,000	SS, Color, pH
28	Chemicals Water Use MGD	2,030,000	29 391.40	11 61.40	14 303	3 26.40	1 .60	406,000	SS, Color, Oil, pH, Grease, Toxic Materials
29	Petroleum Water Use MGD	2,280,000	7 390 . 55	1 1	6 389.55			453,000	SS, Oil, Grease
33	Primary Metals Water Use MCD	565,000	9 299 . 90	3 21.05	3 23.50	2 254.85	1 .50		Toxic Metals, pH, SS, Oil
<u>P1a</u>	anning Area Total Water Use MGD	11,825,000	58 1,514.73	20 130.85	29 1,099.03	5 281.25	4 3.60	1,838,000	

 $[\]frac{1}{2}$ Calculated waste load generated by entire 2 digit SIC group activity constrained by published data. $\frac{2}{3}$ Constrained by published data. $\frac{2}{3}$ SS - Suspended solids.

TABLE L-6(D) SUBREGION D - ESTIMATED PRESENT INDUSTRIAL WASTES PLANNING AREA NO. 16

2 D	Digit SIC Group	Waste Load Before Treat. 1/ (Est. P.E.)	Number of Known Sources	ADEQUACY OF WASTE TREATMENT None Partial Complete Unknown	Discharged Waste Load ² / (Est. P.E.)	Possible Pollutants Other Than Organic Load
20	Food Water Use MGD	193,000			96,000	SS ^{3/} ,Grease, 0il Disease-Bacteria
22	Textiles Water Use MGD	67,000			34,000	SS, Color
26	Paper Water Use MGD	54,000			27,000	SS, Color, pH
28	Chemicals Water Use MGD	166,000			83,000	SS, Color, Oil, pH, Grease, Toxic Materials
29	Petroleum Water Use MGD	104,000			52,000	SS, Oil, Grease
33	Primary Metals Water Use MGD	15,000			7,000	Toxic Metals, pH SS, Oil
<u>P1</u>	anning Area Total Water Use MGD	598,000	36 368.66		299,000	

 $[\]frac{1}{2}$ Calculated waste load generated by entire 2 digit SIC group activity. $\frac{2}{2}$ Derived from waste load before treatment and adequacy of treatment. $\frac{3}{2}$ SS - Suspended solids.

It is estimated that in the future the entire population will be served by at least secondary waste treatment facilities. Projections for future waste loads from non-industrial sources can be found in Table L-7(D).

Industrial Waste Loads: Estimated industrial waste loads, summarized by major types of water-using industries, are presented in Table L-6(D).

The 136 identified major water-using industries in Subregion D substantially contribute to the generation of an organic waste load of 24,123,000 P.E.'s. Under present conditions of treatment, this organic waste load is reduced to 10,310,000 population equivalents before it is discharged to the waters of Subregion D. In addition, the chemical, petroleum, paper, primary metals and mining operations industries produce harmful inorganic wastes which are discharged to the Subregion's waters. It is, however, beyond the scope of this study to determine the magnitude of these waters or their effects on receiving waters.

The projected organic waste loads from the major water-using industries for the design years are given in Table L-7(D). Analysis of this information shows that, although the untreated load is expected to increase nine times, the load after treatment is expected to increase only about two times over the current load. Thus the future industrial waste loads will be an important part of the determination of water quality management programs in Subregion D.

COMBINED SEWER SYSTEMS

Stormwater and municipal wastes are presently collected, transported and discharged through combined sewer systems in 29 known municipalities within Subregion D. These systems serve an estimated population of 4,410,000 people which is approximately 40 percent of the Subregion's entire sewered population. The greatest number of combined sewer systems are located in Planning Area 14 which serve 1,760,000 people and Planning Area 15 which serve 2,600,000 people.

Information is not currently available to estimate either the number of future combined systems or the amounts of waste which these systems will discharge. For purposes of this study, it is assumed that the number of combined sewer systems will decrease through the design period.

Non-Industrial

TABLE L-7(D)

SUBREGION D - PRESENT AND FUTURE ORGANIC WASTE LOADS

SUMMARY

Waste Load a P.E. (000)		Waste Load $\frac{b}{}$ P.E. (000)		Waste Load P.E. (000)		
Year	Before Treatment	After Treatment ^c /	Before Treatment	After <u>Treatment^C</u> /	Before Treatment	After Treatment
1960	11,900 <u>d</u> /	3,860	24,100	10,300	36,000	14,100
1980	13,800	2,080	58,800	8,800	72,700	10,800
2000	17,200	1,700	137,000	13,700	155,000	15,500
2020	21,200	2,120	301,000	30,100	322,000	32,200

Industrial

Total

a/ Includes waste loads from municipalities, institutions and Federal installations.

b/ Includes the waste loads from the six major water-using two digit SIC groups.

c/ This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020.

 $[\]underline{d}$ / Includes 1,590,000 persons not served by non-industrial waste collection systems.

Non-Industrial

TABLE L-7(D) SUBREGION D - PRESENT AND FUTURE ORGANIC WASTE LOADS

PLANNING AREA NO. 14

Waste Load <u>a</u> / P.E. (000)		Waste Load $\underline{b}/$ P.E. (000)		Waste Load P.E. (000)		
Year	Before Treatment	After Treatment	Before Treatment	After <u>Treatment^C</u> /	Before Treatment	After Treatment
1960	4,110 <u>d</u> /	2,170	11,700	8,170	15,810	10,340
1980	5,020	750	25,900	3,900	31,000	4,630
2000	6,080	608	52,300	5,200	58,000	5,840
2020	7,300	730	105,000	10,500	112,000	11,200

Industrial

Total

Includes waste loads from municipalities, institutions and Federal installations.

Includes the waste loads from the six major water-using two digit SIC groups.

This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020.

Includes 1,590,000 persons not served by non-industrial waste collection systems.

TABLE L-7(D)SUBREGION D - PRESENT AND FUTURE ORGANIC WASTE LOADS

PLANNING AREA NO. 15

Non-Industria <u>l</u> Waste Load <u>a</u> / P.E. (000)		Indust Waste P.E. (Load \underline{b} /	Total Waste Load P.E. (000)		
<u>Year</u>	Before Treatment	After <u>Treatment^c</u> /	Before Treatment	After Treatment <u>c</u> /	Before Treatment	After Treatment
1960	6,35 <u>0d</u> /	900	11,800	1,800	18,150	2,700
1980	7,980	1,200	31,500	4,700	39,500	5,900
2000	10,100	1,000	81,000	8,000	92,000	9,200
2020	12,600	1,260	188,000	18,800	201,000	20,000

Includes waste loads from municipalities, institutions and Federal installations.

 $[\]overline{\underline{b}}/$ Includes the waste loads from the six major water-using two digit SIC groups.

This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020.

Includes 1,590,000 persons not served by non-industrial waste collection systems.

TABLE L-7(D)SUBREGION D - PRESENT AND FUTURE ORGANIC WASTE LOADS

PLANNING AREA NO. 16

Non-Industrial Waste Load <u>a</u> / P.E. (000)		Indust Waste P.E. (Load \underline{b} /	Total Waste Load P.E. (000)		
Year	Before Treatment	After <u>Treatment^C</u> /	Before Treatment	After <u>Treatment^C</u> /	Before <u>Treatment</u>	After Treatment
1960	1,450 <u>d</u> /	788	598	299	2,050	1,090
1980	824	125	1,390	200	2,200	300
2000	1,030	103	3,540	360	4,600	500
2020	1,270	127	8,190	820	9,500	950

 $[\]underline{\underline{a}}/$ Includes waste loads from municipalities, institutions and Federal installation $\underline{\underline{b}}/$ Includes the waste loads from the six major water-using two digit SIC groups. Includes waste loads from municipalities, institutions and Federal installations.

This is considered to be a result of actual treatment practice carried out in

¹⁹⁶⁰ and then secondary treatment for 1980, 2000 and 2020.

Includes 1,590,000 persons not served by non-industrial waste collection systems.

SEPTIC TANKS AND CESSPOOLS

Within Subregion D there are more than 500,000 separate housing units, as well as an unknown number of business establishments, which dispose of waste through septic tanks or cesspools. As the density of Subregion D's population increases, the combined effects of these individual disposal systems will become increasingly unsatisfactory. It is expected that through the design period, there will be a significant drop in the percentage of individual systems in relation to the total population of the Subregion.

MINE DRAINAGE

The only notable acid mine drainage in Subregion D occurs in about 200 miles of streams in Planning Area 15. This represents only 10 percent of the affected stream mileage in the entire State of Pennsylvania. Nevertheless, it is of sufficient importance to move the government of that State to undertake abatement measures calling for the expenditure of \$2 million in the Delaware Basin alone. It is expected that a large portion of the acid mine drainage will be treated through the design period.

THERMAL SOURCES

Heat can be a source of pollution resulting from the discharge of "hot" cooling water from fossil and nuclear powered electric generating plants and industrial establishments. Some 35 generating stations are currently operating in Subregion D. At this time, there are only two nuclear stations in stages of licensing.

Projections indicate a greater use of constant run-constant load nuclear or fossil fueled stations to assume the projected base loads, with peaking requirements to be handled by the hydroelectric and fossil fueled stations. It is estimated that the power requirements for the design years will double, triple, and double again over the 10,800 MW installed capacity of 1960.

RECREATIONAL AND COMMERCIAL NAVIGATION

Recreational boating is an important use of the Subregion's waters, with over 150,000 licensed craft reported or registered in 1969. Recreational boating constitutes a source of pollution because of the discharge of human fecal matter, litter, motor exhaust and oil. The magnitude of these sources is unknown at this time. The majority of these problems are concentrated in and near the crowded marinas. With the expected increase in pleasure boating, many of these problems will be accentuated unless appropriate legislation is enacted and enforced.

The discharge of untreated human feces from watercraft in the Subregion represents a potential health hazard, particularly in the crowded marina areas. The States are moving slowly toward legislation for the control of these discharges.

The rapid growth of pleasure boating has resulted in an appreciable increase in dumping of litter, including such materials as plastic food wrap, and glass, metal and cardboard containers. These materials do not readily disintegrate. Some may flow onto the beaches resulting in the deterioration of the aesthetic quality of the environment.

The exhaust from outboard and certain inboard motors is discharged directly into the water, resulting in contamination by hydrocarbon residues. In restricted waters, such as the numerous lagoons, coves and inlets found in Planning Area 16, the concentration of these residues may reach levels detrimental to aquatic life.

Oil pollution can occur as a result of careless operation of recreational boats, but due to the volume of oil involved, this problem is usually limited to restricted waters, such as marinas, where large numbers of boats are concentrated.

The spillage of oil in commercial operations also contributes to the problem of pollution. This particular problem is largely confined to the major harbor areas in Planning Areas 14 and 15. Spills resulting from pumping of bilges from damaged tankers and barges, or from transfer facilities, can cover large areas with sticky oil residue, making shore and waters unsuitable for recreation and causing great loss of marine life. Over 500 initial cases of oil pollution were investigated in the New York Harbor Area in 1966.

RURAL AND URBAN RUNOFF

Information is not available which accurately portrays the magnitude or types of waste loads that are being discharged to the surface waters of Subregion D by rural and urban runoff. Agricultural chemicals, primarily fertilizers and pesticides are spread in large quantities over the surface of the land. During periods of rainfall, excess chemicals are washed into the surface waters or percolate into aquifers. Indiscriminate spillage of sprays and improper disposal of empty pesticide containers can cause serious problems.

Urban runoff is another, and increasingly important, wastewater that is reaching the surface waters of the Subregion. Urban runoff may contain oils, organic matter, trash, inert solids, salts, fertilizers and whatever else can be easily swept or washed into street gutters, storm sewer systems or the nearest water course. This problem is expected to grow steadily as the Subregion undergoes massive urban development.

OCEAN DISPOSAL

The ocean area known as the New York Bight has long been used as a site for the disposal of rocks, mud, dredging, sewer sludge and industrial wastes. A small area off the mouth of the Delaware Bay is similarly used, but to a much lesser extent. Over 15.4 million cubic yards of these materials were dumped in the New York Bight in 1966. The potential discharge to the ocean of the great variety of wastes could have serious ramifications. Unless alternative ultimate disposal methods are found, it is virtually certain that the amount of wastes disposed of in ocean waters will increase significantly through the design years.

CONSTRUCTION ACTIVITIES

Construction activities for both buildings and roadways is and will continue to be of significance in Subregion D. The physical disturbance of the soil cover allows a considerable amount of suspended solids to enter the surface waters of the Subregion. For more detailed information see Appendix Q, "Sediment and Erosion," of the NAR Study Report.

Washing sand and gravel at processing plants is a potential source of pollution by suspended solids; however, most producers remove suspended solids in settling ponds before final discharge. The current concern for water quality makes it unlikely that sand and gravel washing plants without settling ponds will continue to operate for more than a few years. For more detailed information see Appendix H, "Minerals" of the NAR Study Report.

VI. PRESENT AND FUTURE WATER QUALITY PROBLEMS

GENERAL

In Subregion D, the major water bodies near population and industrial centers are seriously degraded by pollution. Stream reaches which currently have water quality problems are shown graphically in Figure D-2 and tabulated in Table L-8(D). In discussing future water quality problems, it is assumed that by 1980 all waste sources will receive at least secondary treatment, and that the resulting water quality of the receiving stream will be adequate to meet State and Federal Water Quality Standards.

Non-industrial and industrial waste loads are considered separately in the following paragraphs. It must be remembered that there are many heavily developed areas where both non-industrial and industrial waste loads are in the same sewer system or in the same water body and cannot be easily identified separately.

For a more detailed discussion of future water quality problem areas resulting from discharges of these types of wastes, refer to Section VII, "Pollution Control Methods -- Treatment Alternatives" of this Appendix.

NON-INDUSTRIAL WASTE LOADS

Non-industrial waste loads include wastewater from municipalities, institutions, and Federal installations. In Subregion D, most rivers are currently receiving treated or untreated non-industrial waste loadings. The major problem areas are the New York Harbor Complex and the Delaware River below Trenton. The 1960 non-industrial waste load of 11.9 million P.E.'s before treatment was reduced to 3.8 million after treatment.

By 2020, the non-industrial waste load before treatment will increase to 21.2 million P.E.'s but will cause a treated discharged load of only 2.1 million P.E.'s; a tenfold reduction of the waste load. Future problem areas are expected to be in the New York Harbor Complex and the Delaware River below Trenton.

INDUSTRIAL WASTE LOADS

The majority of industrial waste load problems in Subregion D are in Planning Area 14. The estimated untreated industrial waste load in Subregion D in 1960 has been reduced by half to 10.3 million P.E.'s after treatment. The expected waste load in 2020 of 301 million P.E.'s

FIGURE D-2

MAP OF

SUBREGION D

WATER QUALITY PROBLEM AREAS

(Located in back of book)

TABLE L-8(D)

SUBREGION D - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus- trial1/	Indus- trial	Thermal ² /	Septic Tanks & Cesspools	Naviga- tion3/	Acid Mine Drain- age	Runoff4/	0ther <u>5</u> /
		<u> P</u>	LANNING AREA	NO. 14				
NORTHEASTERN NEW JERSEY STREAMS								
Newark Bay	x	x	x	1	x		x	a,d
Hackensack River	x	x	x		x		x	a,b,d
Passaic River	x	x	x				x	a,b,d
Arthur Kill	x	x	x		x		x	a,d
Elizabeth River	x	x					x	a,d
Kill Van Kull	x	x	x		x		x	a,d
Raritan Bay	x	x	x		x		x	a,b,d
Raritan River	x	x	x		x		x	a,d
		<u>P</u>	LANNING AREA	NO. 15				
DELAWARE BASIN								
East Br. Delaware River	•			x			x	
West Br. Delaware River	•			x	•		x	
Delaware River	x	x	x		x		x	a,b
Pequest River	*			x			x	c
Lehigh River	x	x				x	x	d
Musconetcong River	x			x	x		x	
Assumpink Creek	x	x		x				đ
Rancocas Creek	x							d
Perkiomen Creek	x							d

TABLE L-8(D) Cont'd SUBREGION D - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus- trial <u>l</u> /	Indus- trial	Thermal2/	Septic Tanks & Cesspools	Naviga- tion <u>3</u> /	Acid Mine Drain- age	Runoff4/	Other5/
		<u> </u>	LANNING AREA	NO. 15 (Cont'	d)			
Schuylkill River	×	x				×	x	đ
Brandywine Creek		x					x	đ
Paulins Kill				x				
Pohatcong Creek	x			x				
		<u>I</u>	PLANNING AREA	NO. 16				
ATLANTIC COASTAL	x	x	х		x			đ
Shrewsbury-Navesink Riv	ver			x	x			d
Shark River	x				x			а
Manasquan River	x			x	x		x	
Metedeconk River	x							а
Toms River	x			х	х		x	
Mullica River	x .							đ
Great Egg Harbor River	x ·				x			u

- $\frac{1}{2}$ Includes wastewater from municipalities, institutions, and Federal installations. Includes thermal wastes from industry and thermal power plants.
- Includes all types of wastes from commercial, recreational and Federal navigation.
- Wastewater containing: a) agricultural chemicals; and b) sediment from agricultural and urban or industrial operations.
- a. combined sewer systems
 - b. nutrient enriched water
 - c. inadequate dilution
 - d. suspect problems but not identified

will be reduced by secondary treatment alone to 30.1 million P.E.'s. Future industrial waste loadings will be primarily of concern in Planning Areas 14 and 15 through the design period.

COMBINED SEWER SYSTEMS

At present, there are 29 combined sewer systems serving some 4.4 million people in Subregion D. These figures are not impressive until one is made aware that nearly half of the sewered population is served by combined sewer systems. It is estimated that there may be 14,440 million gallons per year of overflow (storm water plus sewage) waters in Subregion D. It is suspected that as much as two-thirds of this amount may be coming from 19 known systems in Planning Area 15.

A basic assumption of the NAR is that it is possible to design and implement, by the year 1980, the combined stormwater control facilities needed in Subregion D. Systems carrying only storm drainage or urban runoff would not be a part of this program. It is also assumed that new sewer system construction will be separate sanitary or stormwater systems.

SEPTIC TANKS AND CESSPOOLS

The disposal of wastes through septic tanks and cesspools does not constitute a major problem in Subregion D. However, portions of Planning Areas 14 and 16 have experienced localized difficulties as a result of increasing developments. Future implementation of existing State legislation should end most water quality degradation from this type of waste disposal.

It is expected that some individual waste disposal systems of this sort will remain in existence in the lightly populated rural areas through the design period.

MINE DRAINAGE

Mine drainage is a current problem in one section of Planning Area 15, the Lehigh and Schuylkill Rivers. The State of Pennsylvania has initiated a program which should control the acid mine drainage in Subregion D.

THERMAL SOURCES

Potentially, many of Subregion D's waters will be affected by thermal pollution because of an anticipated rise in electrical power capacity for the design period. This pollution load will depend on the ability of the designers to tailor the new plants to meet established water quality criteria and standards.

Thermal pollution from manufacturing in Subregion D may well increase, due to a projected rise in employment (and consequently new plants) in the chemical and primary metals industries. Conversely, it should be remembered that new processes as well as inplant treatment alter individual loadings.

RECREATIONAL AND COMMERCIAL NAVIGATION

Recreational navigation on a large scale is primarily confined to Planning Area 16 and the southern half of 15. Pollution caused by recreational boating is prevalent in waters with limited circulation and a high density of boats. An expected increase in recreational boating through the design years signifies a proportionate growth in this type of pollution potential.

Commercial navigation is limited to the harbor portions of Planning Areas 14 and 15, the Chesapeake-Delaware Canal, and a few inlets in Area 16. It is expected that the incidence of localized pollution from oil spills and overboard waste disposal could increase, simply because of expansion in the shipping industry.

Another problem related to navigation is the channel maintenance dredging in the harbors. With the expected increase in volume of shipping and ship size, greater amounts of spoil material will have to be disposed of. Suitable disposal sites are becoming scarce.

RURAL AND URBAN RUNOFF

"Agricultural" runoff will increase in Subregion D through the design years. Although information is not available defining the loadings of agricultural chemicals to the surface waters of the Subregion, an indication of the magnitude of this problem can be derived from a review of the data on erosion and sedimentation in the NAR Study Report, Appendix Q, "Erosion and Sedimentation."

While the erodibility factor for Subregion D is the same as the overall average of the NAR Study Area, both erosion and sedimentation rates of Planning Area 14 are the highest in the entire NAR Study Area.

It is estimated that the average erosion rate for urban land is more than five times the rate for crop land.

The entire Subregion will suffer the effects of erosion and sedimentation through the design years. Planning Areas 14 and 15 will experience the greatest problems in the future. Erosion and sedimentation, along with the transfer of agricultural chemicals, cannot be eliminated but can be reduced through conservation measures.

OCEAN DISPOSAL

Wastes, mainly from the New York Metropolitan Area (Planning Areas 13 and 14), are being dumped in the New York Bight. Lesser amounts are also being dumped off the mouth of Delaware Bay from Planning Area 15. Currently, rocks, mud, dredging spoil, sewer sludge, and some industrial wastes are being dumped at sea. Since ocean dumping is often the least costly alternative among the various disposal methods, there is a high degree of interest in ocean disposal. Until the effect of industrial wastes on the pelagic biota is firmly established, ocean disposal should be minimized.

CONSTRUCTION ACTIVITIES

The increase in urban land use in the NAR Study Area is estimated at 150 percent by 2020. This transition period may increase the erosion and consequent sediment load as much as 75 times the current rate. For further discussion refer to the previous section on RURAL AND URBAN RUNOFF.

VII. POLLUTION CONTROL METHODS

Coupled with the Subregion's need for a quantity and quality of water is the upgrading and shifting goals of society. It is no longer sufficient to just supply water; it now must be supplied so that it will maintain a high quality environment as well as support an economic efficiency. This gives rise to conflicts in water use. Pollution, which degrades water quality and impairs reuse, emerges as the most significant water problem.

The following paragraphs present a listing of pollution control methods. The list is intended to be inclusive but not exclusive. In this Subregion, essentially all major known significant sources of pollution exist. Not only do they exist but they are enormous. Therefore, the list of pollution control methods is long and applies in a number of varying ways.

SOURCE CONTROL

The most effective method of protecting the water quality of the Subregion is to prevent pollutants from entering the water. The reduction of the waste loads, the reduction of wastewater volumes, and the alteration of waste load characteristics at their source are some of the methods which can simplify water pollution abatement and control.

The reduction of waste loads and the alteration of waste characteristics is particularly applicable to industrial type wastes. Reductions and alterations can be brought about by 1) within-plant housekeeping, 2) use of non-pollutant substances, 3) reuse of process materials and 4) development of by-products.

As shown in Table L-7(D), untreated industrial waste loads are projected to increase tremendously. A direct reduction of wastes generated reduces the dollar cost of otherwise having to treat these wastes. Altering the wastes to the form of saleable by-products may offer economic returns beyond the cost of treatment savings.

Source control, being universal in nature, plays a direct role in all levels of the Study's three basic objectives, that is: for Environmental Quality the reduced pollution load enhances the environment; for Economic Efficiency the relationship is obvious and for Regional Development the interactions among these objectives provides the background for fulfilling this objective.

Programs of the nature mentioned above are applicable to all industrial activities of the Subregion. In particular, the paper and chemical industries have made significant strides in reducing and

altering their waste products. The food and petro-chemical industries have already developed many by-products of processing and they, along with the aforementioned industries, have research and development programs in this field.

The reduction in volume of wastewater is applicable to both non-industrial and industrial situations. The underlying idea is as follows: The reduction in volume of the vehicle (water) carrying the waste away from the source can significantly reduce the physical size of the facilities required to convey and treat the waste before discharge. Three methods by which these reductions can be accomplished are: 1) for non-industrial sources, educate people to use less water, 2) eliminate infiltration and other multiple connections to sewers, and 3) for industry, separation of waters such as relatively clean cooling waters from process waters, and re-use of process and cooling waters.

TREATMENT ALTERNATIVES

Wastewater from non-industrial and industrial sources generally contains large amounts of pollutional material which is biodegradable. Even with the implementation of all feasible source control measures, many wastes remain that must be treated to ensure adequate assimilation of such wastes by the receiving water, without causing adverse effects upon any other water use. Projections of population and employment indicate organic waste loads will become more of a problem unless adequate treatment measures are provided.

A number of treatment methods and alternatives are available. In this study secondary, tertiary, and advanced waste treatment as well as flow regulation (specifically low flow augmentation) are considered.

In most areas, the resultant instream water quality due to the discharges of secondary treated effluents will at least be equal to that called for by State and Federal Water Quality Standards, until approximately 1980. In a few local areas additional levels of treatment will be required. In Planning Areas 14 and 15 tertiary and advanced waste treatment practices will be required throughout the design period.

To meet anticipated increases in waste loads and the requirements of the Water Quality Standards, approximately 750 secondary wastewater treatment facilities will be needed in Subregion D by 1980. Presently, Subregion D has 494 collection systems of which 255 are of secondary or higher level of treatment.

Because the EPA NAR Study Methodology did not allow full utilization of regionalizatio for larger facilities in densely populated areas or for collection systems in sparsely settled areas less than 750 new plants may have to be built.

Regionalization is quite feasible since most of the population and industry is concentrated in two areas of Planning Areas Numbers 14 and 15, and will probably maintain their relatively high density positions. Also, in Subregion D, the highest percentage of population (98%) and industry (90%) served by collection systems now exists and also will maintain this position through the design years. However, no methodology exists to fully evaluate regionalization in this Subregion.

Another method of reducing the number of needed treatment facilities is to allow for upgrading of present facilities. However, for the purposes of this study, complete replacement has been assumed to be needed every 20 years.

Projections show that in Subregion D a total of about 1600 wastewater treatment facilities will be needed for the year 2000, and for 2020, 3300. The cost data for providing these facilities is given under Financial Considerations.

As was mentioned earlier, supplements to secondary treatment will be needed throughout the study period. In addition, the need for tertiary or advanced waste treatment or low flow augmentation was investigated on a planning area basis. The procedure was in this determination is outlined in Chapter One. The comparison index for required water quality indications by Planning Area for the Target Years is shown below:

Planning Area	<u>1960</u>	<u>1980</u>	2000	<u>2020</u>
14	1.0	2.9	3.6	7.0
15	1.0	2.2	3.4	7.4
16	**	1.0	1.7	3.1

NOTE:

- ** or 1.0 Secondary treatment will suffice to meet water quality standards.
- 1.1 to 1.9 Further study will be needed by this date.
- 2.0 or greater Water quality standards will be contravened on a widespread planning area basis, thus necessitating the use of supplements to secondary treatment levels.

As noted in the Methodology and Rationale Section of Chapter One, both Planning Areas 14 and 15 are exceptions to the general methodology. In Planning Area 14, the base load was derived from a synthetic load after 90 percent BOD (as P.E.'s) removal. In Planning Area 15, the

1960 load after treatment was used as a base load, since this base was obtained from detailed studies and enforcement activities. On the basis of these factors given above, the need for a higher level of treatment or low flow augmentation will be needed in Planning Areas 14 and 15 throughout the design period, and Planning Area 16 will need either further study, higher levels of treatment, or low flow augmentation after the year 2000.

However, flow regulation and low flow augmentation are not waste treatment methods; rather, hey are operational methods aimed at modifying or supplementing river flows to produce a minimum detrimental effect on the water quality of the receiving water.

In coastal planning areas such as Number 16, flow augmentation is not considered a feasible alternate to higher levels of treatment. Comprehensive basin-wide studies are needed to establish sound plans designed to optimize flow regulation.

Excess non-organic waste loads must be considered individually and may have to be controlled by advanced waste treatment processes. Any detailed discussion of this subject is beyond the scope of this study.

STUDY AND MANAGEMENT NEEDS

Various water quality and pollution control needs for Subregion D are evident as a result of work on this Appendix. From a water quality and water pollution control viewpoint, these Type II studies should be conducted on a hydrologic basis for each planning area.

The recommendation to conduct studies in greater detail is based on three major predications: 1) to insure data accessibility, 2) to develop adequate methodology to fill in gaps in data availability, and 3) to provide adequate pollution control surveillance. The lack of these three items soon became apparent as the NAR Study progressed, and the FWQA-NAR Study Methodology was thus tailored to take these items into account.

The following special studies and surveys are integral to providing realistic information for conducting water quality management programs.

Stream Surveillance Programs: Stream surveillance programs must be established as a part of water quality management programs designed to protect and enhance prime water usages, as established by State authorities. Such programs should include a network of manual and automated sampling stations which permit the collection, evaluation and dissemination of water quality data, so as to present a clear picture of conditions in any section of the Subregion. These monitoring stations should be strategically situated near major wastewater sources, so as to alert pollution control authorities to irresponsible or accidental discharge of harmful material. Hence, appropriate corrective actions can be taken immediately.

New Jersey has established a network of 200 stream quality stations, most of which are located on fresh water streams. These stations are sampled regularly four times a year. The State of New Jersey and the U. S. Geological Survey along with the Environmental Protection Agency plan to expand this network, particularly in tidal waters, and to make more use of automated monitoring equipment.

Storage and Stream Flow Regulation: All water resource management programs should provide adequate flow and quality in the Subregion's waters. Comprehensive basin-wide and inter-basin studies are needed to establish sound plans designed to permit optimum beneficial uses of the streams. Such studies should determine the minimum flows required to provide adequate water supply, meet irrigation needs, effect pollution control and allow recreational development. Following these determinations, plans should be developed to coordinate flow releases to meet these needs.

Operation and Maintenance: An adequate program of operation and maintenance at waste treatment plants is necessary to ensure that the existing and recommended new municipal and industrial treatment facilities will be effective in maintaining the designed waste treatment plant efficiency.

Adequate operation of treatment plants requires qualified resident personnel, proper laboratory control, and accurate record keeping. State, interestate and Federal agencies must provide programs aimed at ensuring that these three factors are included at each plant. Because of the limited supply of qualified operating personnel, there is an urgent need for both long and short term training courses in treatment plant operation. Such training should be continuous, and should lead to State licensing of operators. Federally sponsored and conducted training programs have been established to assist in the training of personnel. In order to ensure the successful implementation of any operation and maintenance program, the States must have a sufficient number of trained inspectors to periodically visit plants to review operation and laboratory control methods, and to provide technical assistance to plant personnel.

Municipal and Industrial Waste Inventory: A review of the available data on location, volumes and characteristics of existing municipal and industrial waste discharges within the Subregion indicates a lack of adquate information. There is a need to maintain the data current once an adequate base inventory has been established. The States should develop adequate records providing the latest information on all waste loads for use in planning, and determination of further pollution abatement needs.

Septic Tank Survey: Within Subregion D there are an estimated 1,600,000 persons who dispose of domestic wastes by individual septic tanks or cesspools. There are no adequate data indicating the pollutional effects of such systems. Studies should be conducted to determine the following:

- 1. Location of those areas with large numbers of septic tank systems.
- Determination of the effects that such systems have on surface water and groundwater.
- 3. A plan for eliminating inadequate individual disposal systems by connection to existing or new municipal collection systems. Planning of such systems should be based on regional, inter-county or inter-municipal areas.

While the first two items could be accomplished by the Federal Water Quality Administration in cooperation with State and Federal agencies, the third item is the responsibility of State and local government. Existing Federal grant programs could be used to accelerate the planing, design, and construction of such regional collection systems.

Stormwater Overflow and Urban Runoff: Within Subregion D there are 29 non-industrial sewerage systems that have, at least in part, combined storm and sanitary sewage collection. There is a need to determine the quality and quantity of overflows from such systems, the extent to which such overflows degrade water quality, and similarly, the magnitude and effects of urban runoff flowing directly to the receiving waters.

Thermal Pollution: With the growth in the number and capacity of power plants and the continuing increase in industrial cooling water usage, pollution of the Subregion's waters by heat may become a critical problem. All existing sources of thermal pollution should be identified and determinations made of their effects on the aquatic environment. Plans for new facilities should make provisions so that the wastewaters discharged will meet thermal standards.

<u>Boat Pollution</u>: There is a need to determine the magnitude of the problems associated with the discharge of litter, sewage, and oil from the large numbers of boats in the Subregion. Investigations should include research to develop practical means of controlling this source, surveys to determine the need for adequate disposal facilities at marinas, and a determination of adequate legislation to control such pollution.

Agricultural Runoff: There are limited data available to indicate the extent of water pollution attributable to agricultural runoff. Since runoff from cultivated fields may convey fertilizers, herbicides and pesticides to the receiving waters, the potential dangers of such pollution require investigation. Such a study should include a determination of the types and amounts of agricultural chemicals being used, analytical data to measure the concentration of these chemicals in the receiving streams, and research into allowable concentrations and adequate control measures.

Aquatic Plants and Nutrients: Many areas within the Subregion are plagued by dense growths of aquatic weeds and algae to the extent that interference with beneficial water use results. There is a need for a survey to determine the extent and location of such plant growths, the determination of contributing causes and the development of programs to control the problem. Such control programs should include reduction in the quantities of nutrient materials discharged to the waters as well as means of physical removal of dense plant growths.

<u>Dredging</u>: Since extensive dredging activities are carried out in the Subregion, particularly in the Delaware River and the Jersey Coastal Waters, studies should be made to determine the extent to which such operations are affecting water quality. These investigations should result in the formulation of plans which will help coordinate dredging activities with water resource management and provide guidelines and practices to be followed by dredging operations. Studies of this nature are already underway in the Delaware Estuary.

Bottom Deposits: The extent to which banks of sludge and other substances have accumulated and are affecting the waters of the Subregion is not well known. A combination laboratory and field study is needed to determine the depth and rate of sludge build-up and the oxygen-uptake rate.

Data Systems: With the increasing tempo of data collection by a number of agencies at all levels of government, there is a need for an integrated system of handling water quality and water use data within the Subregion. Such a system, which might be based on the existing Environmental Protection Agency STORET program, would make possible better interchange of knowledge and eliminate duplication of studies. Such an integrated system would further be of great value in permitting the application of such techniques as mathematical modelling and systems analysis in the development of overall water quality management programs.

Regional Cooperation: There is a need for close coordination and water quality management programs to ensure that on-going and future programs consider not only the immediate locality but also the effects upon the Subregion as a whole. Specifically in this Subregion many of these needs are handled by the Delaware River Basin Commission. Studies recommending the creation of regional authorities must ensure that the needs of the smaller river basins are represented, weight and/or integrated into the regional water management programs. Regional authorities may well be the operating mechanism best composed to promote inter-local cooperation between municipalities to coordinate planning among townships and counties, and to administer State and Federal programs.

Legal Framework: To ensure that adequate water pollution control programs are formulated and implemented, there is a need to evaluate existing legal mechanisms and institutional arrangements to determine their adequacy to deal with water quality problems on both a local and a regional basis. At the present time there is a lack of data on the adequacy of existing legal framework, as well as a lack of information on the interrelationships between various authorities and governmental agencies in dealing with the problem of resource management. In a number of localities there is a requirement for additional legislation to zone present and future shoreline developments.

<u>Public Support</u>: In the final analysis, the residents of the Subregion must decide what use is to be made of their resources. Whether or not the decision that is reached is in the best interest of the majority of the residents depends on how well informed they are of the facts concerning the environment and the consequences of their decision or their indecision.

The environment, in which and from which everyone derives existence, has been or is being destroyed by improper utilization. Past damage has been allowed to happen largely because of public apathy or the shortsighted desire for quick and easy monetary gain. Many of the environmental problems in Subregion D are the legacy of past industrialization. By the use of proper planning actions, we must insure that similar charges cannot be leveled at our efforts.

In studies like the NAR Study, and in subsequent studies, every effort should be made to keep the public informed, to stimulate their interest and to enlist their support for water resource planning and management. For it will take informed and dedicated citizens and officials at all levels of government to adequately mobilize effective programs to meet the challenge of solving conflicting water use problems. Although technology may be available, and water also available, people must be made aware of and given the incentive to carry out the corrective measures. Answers must be given as to who is to pay and who is to benefit. An example of the type program needed to carry out this directive is New York State's Project "ABATES". This acronym stands for Ambassadors to Bring Action Through Environmental Study.

<u>Financial</u>: Estimates of the financial investment required for water quality control in Subregion D have been prepared for the design years 1980, 2000 and 2020, and are presented in Table L-9(D). The figures represent the capital investment that will be needed by each of these target years for treatment and other pollution control needs. Operating and maintenance costs for these facilities are not included.

The costs were based on the assumption that complete replacement would take place during each twenty-year period. The complete method-

TABLE L-9(D)

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROLª/

SUBREGION D

Year	Estimated Cost of Secondary Treatment <u>b</u> /	Estimated Addi- tional Cost of Advanced Waste Treatment ^C	Other Cost <u>d</u> /
	PLANNING A	REA NO. 14	
1980	\$ 1,230,000,000	\$ 190,000,000	\$530,000,000
2000	2,300,000,000	350,000,000	
2020	4,500,000,000	700,000,000	
	<u>PLANNING A</u>	REA NO. 15	
1980	500,000,000	35,000,000	2,000,000 <u>e</u> /
2000	3,600,000,000	550,000,000	
2020	8,000,000,000	1,000,000,000	
	PLANNING A	AREA NO. 16	
1980	140,000,000		15,000,000
2000	288,000,000	30,000,000	
2020	597,000,000	55,000,000	
	SUBREGIO	ON TOTAL	
1980	1,870,000,000	250,000,000	547,000,000 <u>e</u> /
2000	6,188,000,000	930,000,000	
2020	13,097,000,000	1,755,000,000	

TABLE L-9(D) Cont'd

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROLª/

SUBREGION D

	Estimated Cost of	Estimated Addi- tional Cost of	
Year	Secondary Treatment	Advanced Waste Treatment ^c /	Other Costd/

a/ For general purpose planning only. Based on 1960 dollars. Costs not to be applied to any individual situation.

 $\underline{b}/$ Based on treating organic waste loads of both industrial and domestic origin. Treatment is considered to be 85% removal for the year 1980 and 90% for the years 2000 and 2020.

c/ Treatment which would remove, in addition to 95% Biochemical Oxygen Demand and 98% suspended solids, up to 98% of nutrients and up to 95% of other materials not removed by conventional treatment methods.

<u>d</u>/ These costs are, where known, estimates for combined sewer overflows control.

e/ Includes \$2,000,000 for acid mine drainage control.

ology used to estimate the cost of treatment, etc., is described in Chapter One of this Appendix.

The figures, given in Table L-9(D), are intended only to serve as indicators of the order of magnitude of financial investment needed in Subregion D for water quality control and are not intended to replace detailed estimates developed as the result of engineering studies for specific municipalities or industries.

RESEARCH AND DEVELOPMENT

Research and development is a major program of the Environmental Protection Agency. The research is conducted primarily to develop improved technology for water pollution control. Programs of research and development are needed in every aspect of water quality and pollution control, specifically those given in Section VII, "Pollution Control Methods - Source Control - Study and Management Needs" of this Appendix.

To provide new and improved methods of pollution control, the EPA research program gives grants to help finance projects which will demonstrate methods for advanced waste treatment, provide new or improved methods for joint treatment of municipal and industrial wastes, and establishes new or improved methods for controlling or preventing pollution cuased by discharges from combined sewer systems. Grant funds are also available to help find practical solutions for the prevention of pollution of waters by industry, mining and pollution associated with natural causes.

VIII. POLLUTION CONTROL PROGRESS

INTERSTATE~FEDERAL

With Subregion D, the Delaware River Basin is the only area which has a governmental mechanism active in water resources management. It is the only full-partnership interestate-federal agreement in the Nation, for water or any other purpose. The signatories to the Delaware River Basin Compact enacted in 1961 are the United States Government and the States of Delaware, Pennsylvania, New York and New Jersey. The Commission's jurisdiction covers a range of water resource management-flood protection, water supply, pollution control, hydroelectric power, recreation, fish and wildlife enhancement and others. Only navigation is excluded. The Commission has an active program of pollution abatement; as of June 1971, 73 abatement schedules were approved in the Delaware Estuary alone.

STATE

All the States of New York, Pennsylvania, New Jersey and Delaware have had established water resource development programs in operation to protect the orderly development of resources. All the States have established interstate water quality standards and implementation plans for achieving these standards. New York, Pennsylvania, and New Jersey have also established standards for their intrastate streams.

In 1965, New York State initiated a six year comprehensive program for the elimination of water pollution in the State. It included and passed a \$1.7 million bond issue to provide the means to accomplish the necessary abatement. All waste discharges in New York State will be required to have a minimum of secondary treatment or the equivalent by 1972.

In 1966 the Pennsylvania legislature passed a \$500 million bond issue which was subsequently approved by the voters. Included were provisions for \$100 million in sewage treatment plant construction grant purposes and for \$150 million in initial mine drainage pollution abatement.

New Jersey classified all the surface waters of the State in September 1964. Implementation of the abatement schedules has progressed as the requirements of acceptable degrees of treatment for each drainage area are formulated. In general, the standards call for installation of secondary treatment or the equivalent, as a minimum, for all municipal and industrial wastes by November 30, 1970; except for the Delaware River Basin where the terminal date is January 30, 1971.

The State of Delaware has recently begun a more effective pollution control program. All new waste discharges are required to receive a minimum of secondary treatment or the equivalent, and all existing waste discharges which do not currently receive secondary treatment or the equivalent shall be upgraded with some exceptions. These exceptions are recognized only when all reasonable water uses and all the water quality criteria are satisfied with less than secondary treatment.

FEDERAL

The Water Quality Act of 1965, as amended, contains authorization for increased Federal involvement in efforts to eliminate pollution and enhance water quality in the Nation's waters. The Act also braodened the mechanism through which the Federal government would share in the cost of financing new waste treatment facilities. As of July 1969 some 288 projects in Subregion D are either under construction or completed. Some \$248 million are being expended on these projects, of which some \$56 million is from Federal funds.

The table below indicates data for the appropriations by entire State as of November 1969 in construction grant programs. As indicated above, only a portion of these funds is applicable to the NAR Study area.

State	Number of <u>Projects</u>	Approved <u>Cost</u>	Federal Share
New York	411	\$825,420,128	\$97,200,039
Pennsylvania	346	363,624,902	75,195,977
New Jersey	141	148,221,523	40,674,293
Delaware	36	27,876,369	8,456,732

In conjunction with the funding of pollution abatement facilities, the Federal government also is authorized to, when requested by a State, hold an enforcement conference to ascertain the necessary abatement measures. A compliance schedule is made a part of such conferences. In the past 10 years both Raritan Bay and the Jersey Coastal waters, and their tributaries, have been the subject of enforcement conferences.

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY

APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 6

SUBREGION E

ENVIRONMENTAL PROTECTION AGENCY WATER PROGRAMS OFFICE May 1972

CHAPTER 6

SUBRECTON E

I. INTRODUCTION AND SUMMARY OF FINDINGS

Chapter 6 is a report of current and projected water quality conditions in Subregion E. This Subregion includes the portions of New York and Pennsylvania drained by the Susquehanna River and the local drainage of the Chesapeake Bay.

This Chapter is intended to provide a broad-scaled analysis of water quality problems in Subregion E and to furnish general appraisals of the probable nature, extent and timing of measures for their solution. The material presented in this Chapter is based on general relationships, reasoned approximations, available data, and the judgment of experienced planners. The material should be used in the context of a framework study and should be considered preliminary or reconnaissance—type in nature.

SUMMARY FINDINGS

- 1. Subregion E is the largest of the six NAR regions with an area of 33, 693 square miles. The drainage area of the Susquehanna River, the largest river in the Eastern United States (27,500 square miles), accounts for more than 80 percent of the surface area. The Chesapeake Bay is also included in this Subregion.
- 2. The Subregion's 1960 population was 5,372,296 and is projected to increase to 10,358,700 by 2020 (an increase of 93 percent). Based on 1960 population the Subregion is relatively sparsely settled with a population density of 159 persons per square mile. Compared to other NAR Subregions, Subregion E has a high proportion of its labor force engaged in manufacturing employment. This relative proportion is expected to increase in the future.
- 3. The water resources of Subregion E are presently being used for various and, in many instances, conflicting purposes. The use of these waters can generally be described in the following categories: municipal and industrial water supply, recreation, commercial fishing, commercial navigation, power generation and irrigation. Of these uses, municipal and industrial water supply accounted for 1580 mgd (million gallons per day) of water use in 1960. By 2020, this use is projected to increase to 9960 mgd.
- 4. Waste sources in Subregion E are varied and numerous. The most significant result from industrial and non-industrial activities, rural and urban runoff, thermal discharges, recreation, and commercial navigation. Industrial and non-industrial sources or organic

waste loads presently discharge 2.74 million P.E. (population equivalent) of BOD (biochemical oxygen demand) to the waters of the Subregion. Non-industrial sources account for approximately 60 percent of the loading. The paper and chemical industry contribute over 36 percent of the total industrial waste load. Mine drainage pollution has adversely affected more than 1200 miles of streams in the Susquehanna River Basin. Abandoned mines are a more significant source of mine drainage discharge than are active mining operations.

- 5. Future untreated organic waste loads will increase to 11 million P.E.'s in 1980, 18 million in 2000 and 30 million in 2020. By providing secondary treatment the BOD loading from these waste loads could be reduced by approximately 85 percent. In Subregion E there are 48 known areas where treatment levels higher than secondary will be required to meet water quality standards. Nutrient removal will be required in some areas.
- 6. It is estimated that the cost of providing secondary treatment facilities for the waste loads anticipated in the design years 1980, 2000 and 2020 will be \$616 million, \$996 million and \$1,661 million, respectively.
- 7. Water quality planning studies are in various stages of development throughout Subregion E. In addition to the NAR study, a Type II comprehensive water resources study on the Susquehanna River Basin was completed and published in June 1970. The Appalachia Water Resource Study coverying portions of the Subregion has been published. The Federal interagency study of the Chesapeake Bay has been initiated in addition to an ongoing State interagency planning effort on the Bay. All the states in Subregion E have active pollution abatement programs, and Federal, State and local funds are being utilized to implement action programs to abate water quality pollution. Progress is being made toward achieving water quality objectives but more needs to be done.

FIGURE E-1

MAP OF

SUBREGION E

LOCATION AND BOUNDARIES

(Located in back of book)

TABLE L-1(E)

SUBREGION E - PLANNING AREAS

Planning	Grouping of Whole	Complete and Partial
Area	Counties in the	Major River Basins
Number	Planning Area	Within the Planning Area
17	Steuben, N. Y. Chemung, N. Y. Tioga, N. Y. Cortland, N. Y. Broome, N. Y. Madison, N. Y. Chenango, N. Y. Otsego, N. Y. Potter, Pa. Tioga, Pa. Bradford, Pa. Susquehanna, Pa. Cameron, Pa. Clinton, Pa. Lycoming, Pa. Sullivan, Pa. Wyoming, Pa. Sullivan, Pa. Wyoming, Pa. Clearfield, Pa. Centre, Pa. Union, Pa. Northumberland, Pa. Montour, Pa. Columbia, Pa. Luzerne, Pa. Blair, Pa. Bedford, Pa. Huntingdon, Pa. Mifflin, Pa. Juniata, Pa. Snyder, Pa. Perry, Pa. Cumberland, Pa. York, Pa. Dauphin, Pa. Lebanon, Pa. Lancaster, Pa.	Susquehanna River Chemung River West Branch Susquehanna River Lackawanna River Juniata River

TABLE L-1(E)(Continued)

Planning	Grouping of Whole	Complete and Partial
Area	Counties in the	Major River Basins
Number	Planning Area	Within the Planning Area
18	Carroll, Md. Baltimore, Md. Harford, Md. Cecil, Md. Howard, Md. Anne Arundel, Md. Calvert, Md. Kent, Md. Queen Annes, Md. Talbot, Md. Caroline, Md. Dorchester, Md. Wicomico, Md. Somerset, Md. Worcester, Md. Accomack, Va. Northampton, Va. Sussex, Del.	Chesapeake Bay Drainage including: Patuxent River Chester River Choptank River Nanticoke River Pocomoke River

TABLE L-2(E)

SUBREGION E - MAJOR RIVERS AND TRIBUTARIES

Name	Length (Miles)	Drainage Area (sq. mi.)
Susquehanna River	444	27,500
Chemung River	44	2,520
Lackawanna River	40	346
West Branch	228	6,913
Juniata River	86	3,426
Chesapeake Bay	180	64,000
Patuxent River	110	930
Chester River	56	446
Choptank River	79	795
Nanticoke River	65	815
Pocomoke River	65	488

II - DESCRIPTION OF SUBREGION

A. LOCATION AND BOUNDARIES

Subregion E includes part of the State of New York, Pennsylvania, Maryland, Virginia, and Delaware. The geographic boundaries of Subregion E are shown in Figure E-1.

Subregion E has been divided by the Coordinating Committee into two water resource planning areas (Areas 17 and 18) delineated by county boundaries. Table L-1(E) lists the areas, the counties, and the major rivers in each planning area.

B. PHYSICAL FEATURES

1. General Hydrology

The major river system in the subregion are the Susquehanna, Chemung, West Branch, Juniata, and Patuxent. The location of these rivers are shown in Figure E-1. With the exception of a few small streams which flow into the Atlantic Ocean, all rivers in the Subregion eventually discharge into the Chesapeake Bay. The Susquehanna River, with a drainage area of 27,500 square miles, is the largest stream in the eastern United States. Flows from the Susquehanna River make up about 50 percent of the freshwater inflow into the Chesapeake Bay. The lengths and drainage areas of the major streams and tributaries of the Subregion are presented in Table E-2. More detailed hydrologic information is presented in Appendix C.

2. General Geology and Topography

Planning Area 17 is composed almost entirely of the Susquehanna River Basin drainage. In its 444 mile course from Lake Otsego, New York, to the mouth at the head of the Chesapeake Bay, the Susquehanna River flows through terrain characterized by rolling, patternless mountains in the north; by rugged mountains and well-defined valleys in the middle portion of the basin; and low, rolling hills and wide, limestone valleys in the south. Elevations vary from a few feet above sea level at the Pennsylvania-Maryland State Line to 2,6000 feet MSL south of Great Bend, New York, and near Altoona, Pennsylvania.

There are extensive coal deposits in the central and western parts of Area 17. The mining of this coal has been important in the economic development of the Nation. The drainage from abandoned mines has polluted many miles of streams. Strip mining operations in the area have denuded tracts of previously forested land.

Except for the headwaters of the Patuxent River, all of Area 18

is in the Coastal Plain geophysical province and is characterized by very flat and generally low terrain having basically sandy soil. The streams in the area are sluggish and essentially tidal throughout most of their length. Because of the moderate reliefe, the groundwater table is often near or at the surface, making drainage difficult and interfering with the operation of septic tank drainage fields.

C. CLIMATE

The climate of Subregion E is temperate with moderate, seasonal changes. Average annual temperatures vary from 46°F near Lake Otsego, New York, to 56°F on the eastern shore of Maryland. Rainfall is well distributed throughout the year with the lowest monthly average of 2.29 inches in February and the highest monthly average of 4.63 inches in May. In the northernportion of the Subregion, an average of 41 inches of snow occurs annually.

III - ECONOMY

A. AREAS

Subregion E has been divided into two areas for study purposes. These areas are based on a political subdivision of the Subregion rather than hydrologic boundaries and, as a result, each area consists of groups of whole counties. Table L-1(E) lists the planning areas, the counties, and the whole or partial river basins included.

B. SELECTED ECONOMIC MEASURES

Subregion E, located southwest of the New York - Philadelphia metropolitan areas, is the largest in size of the six NAR regions, with 33,693 square miles. The Subregion's 1960 population was 5,372,296 and will rise to 10,358,700 by 2020 (an increase of 48 percent). On a population density basis, Subregion E was sparsely populated in 1960 with 159 persons per square mile, and it will increase slightly by the year 2020 to 307 persons per square mile. In this Region, there are 56 counties which are situated in the states of New York, Pennsylvania, Delaware, Maryland, and Virginia. Eight SMSA's and 18 urban centers, including Baltimore City, are in this region.

Although this particular Subregion is relatively small by most economic yardsticks, it is the third ranking Subregion in terms of its number of manufacturing workers per 1000 employed. By 2020, Subregion E will rank second in this manufacturing worker-total employment relationship. The higher ranking in this category does reflect positive growth of the manufacturing employee even though the ratio will decrease from 336 manufacturing workers per 1000 total employed in 1960 to 272 manufacturing workers per 1000 total employed in 2020. It should be noted that on the basis of per capita personal income, Subregion E's level of \$1,993 in 1960 was lower than the U.S. average of \$2,134 and the NAR Study area's average of \$2,414. The Subregion's per capital personal income level will increase greatly by 2020, to the level of \$12,192, which will remain less than the anticipated U.S. average of \$12,411 and the NAR average of \$13,477. Subregion E will reflect a 512 percent increase in per capita personal income between 1960 and 2020.

TABLE L-3(E)

SUBREGION E - SELECTED ECONOMIC MEASURES

ECONOMIC MEASURES	1960	1980	2000	2020
Population	5,372,296	6,670,000	8,347,400	10,358,700
Total Personal Income (\$000) (1958 Dollars)	10,708,400	26,474,257	57,978,848	126,301,927
Per Capita Income ^{a/} (1958 Dollars)	1,993	3,969	6,945	12,192
Total Employment	2,015,657	2,669,900	3,387,300	4,181,000
Agriculture + Forestry + Fisheries	98,886	69,400	50,000	35,500
Mining	22,315	8,300	5,800	4,500
Total Manufacturing	677,448	836,200	978,000	1,138,700
Six Major Water-using Industries Total	214,535	233,500	253,700	279,900
20 Food and Kindred Products 22 Textile Mill Products 26 Paper and Allied Products 28 Chemicals and Allied Products 29 Petroleum Refining 33 Primary Metals All Other Manufacturing Employment	73,809 28,307 18,144 25,800 2,897 65,578 462,913	70,200 21,500 26,900 37,700 5,700 71,500 602,700	67,700 15,300 35,700 52,400 6,100 76,500 724,300 34,900	65,900 11,300 46,400 68,500 6,600 81,200 858,800
Armed Forces (number)	1,182,049	1,721,400	2,318,600	2,967,200
All Other Employment Categories	1,102,049	1,721,400	2,310,000	2,507,200

 $[\]underline{a}/$ Based upon 1959 population and personal income reported in 1960 Decennial U.S. Census.

Source: North Atlantic Regional Water Resources Study, Appendix B, Economic Base,
Prepared by Office of Business Economics, Regional Economics Division, U.S. Department of Commerce.

IV - PRESENT AND FUTURE WATER USE

A. GENERAL

Water Resources of the Subregion are utilized for a wide variety of purposes, ranging from pure aesthetic enjoyment to industrial cooling and processing. These uses are not always compatible, and when one use is emphasized to the detriment of another use, a water quality or water supply problem may be created. Some of the more important current and expected water uses in Subregion E are discussed in this chapter.

B. MINICIPAL AND INDUSTRIAL WATER SUPPLY

Municipal water supply systems in Subregion E serve an estimated population of 4.4 million. By 2020, the total population served is expected to reach 8.8 million. In 1965, 2153 MGD was used for municipal and industrial purposes, and the use is expected to increase to 13,595 MGD by the year 2020.

Although some localized areas have experienced water supply shortages in the past, and the future demand is expected to increase significantly; on an overall basis there are sufficient quantities of water within the Subregion to meet current and projected demands. In order to avert possible future shortages, the water resources of the Subregion must be intelligently managed and developed.

Water is currently diverted out of the lower reaches of Area 17 into Area 18 to meet water supply demands at Baltimore, Maryland. This diversion amounted to approximately 50 mgd in 1968 and is expected to be as much as 300 mgd in 2020. By 2020, approximately 100 mgd is expected to be diverted to Subregion D to meet demand in the Chester, Pennsylvania area. Until recently, many previous studies of Area 17 suggested utilizing the waters of this area for meeting the increased demands of metropolitan centers along the East Coast. These earlier studies considered Area 17 to be a "water rich" area, having sufficient quantity of available water for future water resource development to meet increasing needs. However, in view of the more recent studies, before any such proposals are seriously considered or plans formulated, all of the hydrological, ecological, socio-economic, and legal ramifications of potential interbasin diversions should be thoroughly evaluated and understood.

C. RECREATION

The Outdoor Recreation Review Commission report indicates that the demand for water-based recreation is Subregion E will increase rapidly in the immediate future due to the location of the Subregion

TABLE L-4(E) SUBREGION E - PRESENT AND FUTURE WATER USE $\frac{1}{2}$

Water Body	Water Supply	Shell- fishing	Bathing	Fishing	Agric., Ind., Navig. & Other
		Present Use	0 =	Future Use	
Susquehanna River	xo		xo	xo	хо
Chemung River	xo		o	xo	xo
Lackawanna River	О		0	0	0
West Branch	O		0	О	xo
Juniata River	xo		xo	xo	xo
Chesapeake Bay		xo	xo	хо	хо
Patuxent River	0	xo	xo	xo	xo
Chester River	· 0	xo	xo	xo	xo
Choptank River	O	0	хo	xo	xo
Nanticoke River	O	0	xo	хо	xo
Pccomoke River	o	o	xo	xo	xo

Water uses are for the stream in general and not for any specific reach.

 $[\]frac{1}{2}$ / Water uses are for the stream in general and not for any specific $\frac{1}{2}$ / Future uses are those called for in the water quality standards.

in the center of three of the most vigorously growing urban regions in the United States. North and east of the Subregion is located New York City, northernNew Jersey, Philadelphia, Albany, and Buffalo. To the west is the populous northeastern Ohio urban industrial complex as well as Pittsburgh, Pennsylvania. Adjoining the Subregion is the Washington, D.C., Metropolitan Area. All of these urban areas are well within the recreational market area of the Subregion.

The water oriented recreational potential of this Subregion is enormous. There is a total of approximately 15,000 miles of rivers and streams in Area 17 and 4,500 miles of shorelines in the Chesapeake Bay. There are numerous Atlantic Ocean beaches on the Eastern Shore of Maryland and Virginia. At the present time in Area 17, pleasure boating accounts for almost six million user-days per year, and other water-oriented recreational activities total more than 25 million days a year. The Bureau of Outdoor Recreation expects this demand to increase about six-fold by 2020. Recreational boating and fishing are favorite pastimes on the waters of the Chesapeake Bay.

The ChesapeakeBay, especially the Susquehanna Flats at the northern end of the Bay, is a favorite feeding and breeding ground for waterfowl. Hunting waterfowl is conducted on nearly all water of the Bay. Water contact recreation is limited in the Chesapeake Bay because of lack of public access to the waters, summer abundance of stinging jellyfish, and high turbidities (probably due to phytoplankton).

The Subregion's recreation potential is enormous, but poor water quality often restricts the full utilization of the resource.

D. COMMERCIAL FISHING

Commercial fishing in the Subregion is concentrated in Area 18 (Chesapeake Bay and tidal estuaries). The primary types of fish and shellfish caught are blue crabs, oysters, menhaden, soft crabs, alewives, swellfish, and seed oysters. The total weight of the 1966 landings was 501 million pounds, and the dockside value of the landings was 35.3 million dollars.

There is considerable variation from year to year in the value and volume of the catch. This variation is believed to be caused principally by variations in weather conditions. There has been no observable long-term decrease in the colume or value of the fish and shellfish catch in the Chesapeake Bay. However, there may be a tendency in Chesapeake waters for a decrease in diversity of species. While total catches have remained fairly level, the weakfish, spot, and croaker have almost entirely left the fishery. This lack of diversity is a characteristic of stress on population and may be a first symptom of environmental degradation rather than over exploitation.

E. COMMERCIAL NAVIAGION

The Port of Baltimore, in Area 18, is the country's fourth largest port in foreign trade volume. In 1968, the Port handled 22.5 million long tons of foreign ocean-borne commerce valued at nearly \$1.8 billion. There are numerous smaller ports in Area 18 that are locally important to Chesapeake Bay commerce. Since there is presently a significant net outflow of fresh water from the upper end of the ChesapeakeBay into Delaware Bay through the Canal, the hydrological and ecological impact of this enlargement should be carefully investigated.

The C and D Canal which connects the upper end of the Chesapeake Bay to the Delaware Estuary is an important navigation artery in Area 18. The Canal is currently 27 feet deep and 250 feet wide, but construction is underway of increase the dimensions of the Canal to 35 by 450. Since there is a tendency for fresh water to flow out of the upper end of the Chesapeake Bay through the Canal, the hydrological and ecological impact of this enlargement should be carefully investigated.

F. POWER GENERATION

There are 21 significant power generating facilities in the Subregion; five of these are hydro-power, 14 are coal or oil fired steam generating plants, and two are nuclear fired steam generating plants. Much of the projected increase in power generation is expected to occur in the lower portion of Area 17 and around the shores of the Chesapeake Bay. Also, most of the proposed capacity will be nuclear fired. The installed generating capacity in Subregion E was 8236 megawatts in 1968, and is expected to increase to 2145.5 megawatts by 2020. If some form of forced cooling is not installed at the proposed plants, a definite water quality problem will be created by the heated discharges.

G. IRRIGATION

The use of irrigation systems in the Subregion is concentrated in Area 18 and in the lower portion of Area 17. In 1964, about 13,660 acres of farmland were irrigated in Area 17 and 29,943 acres in Area 18. Area 18 represents one of the largest potential areas for increase in irrigation in the North Atlantic Region. Projections by the Department of Agriculture indicate that by 1980 about 29,300 acres of farmland will be irrigated in Area 17 and 58,700 acres in Area 18.

V - WATER QUALITY CONTROL

A. PRESENT WASTE LOADS

1. General

Industrial and non-industrial waste sources currently discharge approximately 2,740,000 population equivalents to the waters of Subregion E. In addition to this organic pollution, it is estimated that more than 1 million pounds of acid per day are discharged to the waters of Planning Area 17 from abandoned mining operations. Other sources, such as combined sewers, navigation, rural and urban runoff, and construction activities, also contribute to the pollution load of the Subregion. The following is a discussion of the most significant sources of pollution.

2. Non-Industrial Waste Loads

There are 362 known sources of non-industrial waste which discharge to the surface waters of Subregion E. Selected information concerning these sources is presented in Table L-5(E).

In 1960, approximately 68 percent of the total Subregion population (5,372,000) was served by sewage systems. The waste from about 19 percent of the population served by sewers was discharged to the receiving waters before receiving any treatment, 25 percent received primary treatment, and 55 percent received secondary treatment. It is estimated that the wastes equal to 1.6 million population equivalents is currently discharged to waters of the Subregion from non-industrial sources.

3. Industrial Waste Loads

Present industrial waste loads for the entire Subregion, and for Planning Areas 17 and 18, summarized by major types of water-using industry, are presented in Table L-6(E).

The 383 known major water-using industries in the Subregion generate a waste equal to 2.1 million population equivalents (P.E.'s). Although most of the industries provide some degree of treatment, an organic waste equal to that produced by a population of 1.1 million people is discharged to the surface waters of the Subregion. In addition, some industries such as the chemical and paper industry produce harmful inorganic wastes which are not removed by conventional treatment processes.

4. Combined Sewers

Storm water and industrial wastes are collected, transported, and discharged through combined sewer systems in 42 known sewage

TABLE L-5(E)

ESTIMATED PRESENT NON-INDUSTRIAL WASTE DISCHARGES*
SUBREGION E

	DEGREE OF TREATMENT									
Area	Sub- Total	Unknown	None	Pri- mary	Inter mediate	Secon- dary	Adv. Waste Treat.	Over- loaded; Outdated	Systems Not Chlori- nating	Combined Storm- Sewer Systems
17										
No. of Systems	284		117	81	4	83				
Pop. Served (000)	2,031		628	706	17	680				
Waste Load Disch.										
Cal. P. E. (000)	1,196		628	459	7	102				
18										
No. of Systems	77		14	25		38				
Pop. Served (000)	1,683		75	241		1,377				
Waste Load Disch.										
Cal. P.E. (000)	439		75	157		207				
Subregion Total										
No. of Systems	362		131	106	4	121				
Pop. Served (000)	3,714		703	947	17	2,057				
Waste Load Disch.										
Cal. P.E. (000)	1,635		703	616	7	309				

^{*} Includes municipal, institutional, and Federal installation wastewater discharges.

TABLE L-6(E)

ESTIMATED PRESENT INDUSTRIAL WASTES

SUBREGION E - SUMMARY

2 Digit SIC Group	Waste Load Before Treatment (PE)	Number of Sources Known	Water Use (mgd)	Adequ			reatment Unknown	Waste Load Poss. Poll. Discharged Other Than (PE) Organ. Load
20 Food	1,149,000	216	68.4	40	168	8	2009	618,000
22 Textiles	53,000	27	4.8	3	19	5	-	35,000
26 Paper	446,000	28	24.4	6	19	3	-	192,000
28 Chemicals	319,000	40	51.9	15	20	5	-	208,000
29 Petroleum	4,000	11	102.1	4	7	-		3,000
33 Primary Metals	85,000	18	727.8	3	15	-	-	43,000
10-14 Mining	3,000	43	66.8	-	_	-	-	2,000
Area Total	2,109,000	383 1	,047.2	71	248	21	-	1,101,000

TABLE L-6(E)

ESTIMATED PRESENT INDUSTRIAL WASTES

SUBREGION E - AREA 17

2 Digit SIC ¹ / Group	Waste Load Before Treatment (PE)	Number of Sources Known	Water Use (mgd)	Adequ			reatment Unknown		Poss. Poll. Other Than Organ. Load
20 Food	685,000	182	36.6	25	149	8	gree .	284,000	$SS^{2/}$, Grease, Oil, Bacteria
22 Textiles	48,000	26	3.8	2	19	5	-	30,000	SS,Color
26 Paper	434,000	24	20.2	6	1 5	3	-	186,000	SS,Color
28 Chemicals	163,000	19	9.0	2	12	5	-	82,000	SS,Color, Oil,Grease, Toxic Material
29 Petroleum	-	0	_	-	-	-	-	-	-
33 Primary Metals	3,000	7	23.2	-	7	-	-	1,000	
10-14 Mining	3,000	43	66.8	_	-	-	-	2,000	Sediment
									·
Area Total	1,336,000	301	159.6	35	202	21	-	585,000	

^{1/} Standard Industrial Classification

^{2/} Suspended Solids

TABLE L-6(E)

ESTIMATED PRESENT INDUSTRIAL WASTES

SUBREGION E - AREA 18

2 Digit SIC Group	Waste Load Before Treatment (PE)	Number of Sources Known	Water Use (mgd)				reatment Unknown		Poss. Poll. Other Than Organ. Load
20 Food	464,000	34	31.8	15	19	-	-	334,000	SS ¹ /,Grease, Oil,Bacteria
22 Textiles	5,000	1	1.0	1	_	_	-	5,000	SS,Color
26 Paper	12,000	4	4.2		4	-	-	6,000	SS,Color
28 Chemicals	156,000	21	43.9	13	8	-	-	126,000	SS,Grease, Color,Toxic Material
29 Petroleum	4,000	11	102.1	4	7	-		3,000	SS,0il
33 Primary Metals	82,000	11	704.6	3	8	-	-	42,000	Toxic Metals, SS,0il
10-14 Mining	-			-	-	-	-	-	
Area Total	773,000	82	887.6	36	46	0	0	516,000	

service areas within Subregion E. All of these combined systems are located within Area 17. These municipal systems serve an estimated 2 million people or approximately 55 percent of the total population served by sewer systems. The extent of existence of combined sewers in Area 18 is not presently known.

5. Septic Tanks and Cesspools

Within the Subregion there are more than 573,000 separate housing units, as well as an unknown number of businesses and institutional establishments which dispose of waste through septic tanks or cesspool systems. By 2020, in Area 17, it is estimated that 188,000 people will rely on individual waste disposal systems.

6. Mine Drainage

Field investigations have located 1150 mine drainage discharges in Area 17. It is estimated that more than 1 million pounds of acid per day are discharged to the waters of Area 17 from all mine drainage sources. About 55 percent of this discharge comes from the bituminous fields in the West Branch, Juniata, and Tioga River Basins. The remaining 45 percent originates in the anthracite fields of the Middle Susquehanna area. The drainage from abandoned mines contributes more pollution than do the active mines. There are no significant mine drainage pollution sources in Area 18.

7. Thermal Sources

Thermal electric power generating plants are the most significant source of thermal discharges within Subregion E. In 1968, 8236 megawatts or electricity were produced in the Subregion at 36 major plants. Presently, the largest thermal loads are being discharged in the lower reaches of Area 17.

Present planning by electric power companies indicates that the lower portions of Area 17 and the Chesapeake Bay Area will be extensively developed to meet the increasing electric power demands of the surrounding area. Several large atomic generating facilities are planned for construction in the mid-1970's.

8. Recreational and Commercial Navigation

Although pollution from recreational craft can cause serious degradation in marinas and other areas where the boats concentrate, the problem is usually very localized and not considered a major problem in the Subregion.

In 1964, there were 5100 arrivals of commercial craft at the Port of Baltimore. From 1964 to 1966 there were 20 cases of oil pollution investigated in Baltimore Harbor.

9. Rural and Urban Runoff

Increasing use of chemical fertilizers and pesticides have magnified the threat of pollution from land runoff in the Subregion. The threat of this type of pollution is particularly acute in lower reaches of Area 17 and in Area 18 where there is extensive agricultural activity.

It is suspected that urban runoff adds a significant amount of pollutants to the waters of the Subregion. The extent and the seriousness of this problem is not currently known.

10. Ocean Disposal

Ocean disposal is not a problem in this Subregion.

11. Construction Activities

Current and past construction activities have cause sediment problems in the Subregion. In Area 17, the most widespread sediment loads are carried by streams draining the coal fields. Sediment discharge measurements by the Geological Survey indicate that about three million tons of suspended sediment are carried annually by the Susquehanna River.

B. PROJECTED WASTE LOADS

Non-industrial and industrial waste loads were projected based on population and industrial productivity data developed by the Office of Business Economics, respectively. The population projections used are shown in Table L-3(E).

The projected productivity of the major waste-producing industries in the Subregion are shown below:

PROJECTED INDICES OF PRODUCTIVITY

			Index of Productivity						
			•	Design Year					
		Base	19	80	20	00	20	20	
		Year	Ar	ea	Ar	ea	Ar	ea	
Industry	SIC	1960	17	18	17	18	17	18	
Food	20	1.0	1.80	1.85	3.80	33.12	5.10	5.63	
Textiles	22	1.0	1.92	1.37	2.94	1.91	4.51	2.77	
Chemicals	28	1.0	3.79	3.68	12.19	13.57	28.28	35.73	
Paper	26	1.0	2.09	2.81	3.97	6.60	7.42	14.59	
Petroleum	29	1.0	4.47	4.22	15.76	9.87	50.51	19.90	
Primary Metals	33	1.0	1.83	2.05	2.83	3.62	4.56	6.46	

These production factors are based on a 1960 index of 1.0.

Based on the above data, the projected industrial and non-industrial waste loads for Subregion E were compared and are shown in Table L-7(E).

Presently non-industrial waste loads in the Subregion exceed industrial waste loads 2 to 1. By the year 2020 this relationship is expected to be reversed, with industrial discharge exceeding nonindustrial.

TABLE L-7(E)

SUBREGION E - PRESENT AND FUTURE ORGANIC WASTE LOADS

SUMMARY

Industrial_b/Waste Load, b

Total

Waste Load,

(P.E.) 000 (P.E.) 000 (P.E.) 000 Before After Before After Before After <u>Treatment^C/</u> <u>Treatment</u>c, Year Treatment Treatment Treatment Treatment 5,372 1960 1,619 2,023 1,101 7,395 2,720 1980 6,670 1,000 4,387 11,057 657 1,657 2000 8,347 1,251 9,458 1,419 17,805 2,670 2020 10,358 . 1,551 19,359 2,902 29,717 4,453

 \underline{a} / Total population equivalents (PE) based on OBE projection of population.

Non-Industrial

Waste Load, a/

- b/ Projections made by multiplying (present, 1960, estimated gross waste load generated) x (OBE) projected output index). Based on total SIC Groups for the following 2 Digit Groups: 20, 22 26, 28, 29, 33, and 10-14.
- c/ Present treatment practices for 1960, secondard treatment for 1980, 2000, and 2020.

TABLE L-7(E) SUBREGION E - PRESENT AND FUTURE ORGANIC WASTE LOADS

AREA 17

Total

	Non-Industrial Waste Load, <u>a</u> / (P.E.) 000			strial Load, <u>b</u> / L) 000	Total Waste Load, (P.E.) 000		
<u>Year</u>	Before Treatment	After Tr <u>eatment^c</u> /	Before Treatment	After Treatment <u>c</u> /	Before Treatment	After <u>c</u> /	
1960	3,187	1,196	1,336	585	4,523	1,781	
1980	3,903	585	2,856	427	6,759	1,012	
2000	4,902	735	5,915	887	10,817	1,622	
2020	6,097	912	11,534	1,730	17,631	2,642	

Total population equivalents (PE) based on OBE projection of population.

Projections made by multiplying (present, 1960, estimated gross waste load generated) x (OBE) projected output index). Based on total SIC Groups for the following 2 Digit Groups: 20, 22 26, 28, 29, 33, and 10-14.

c/ Present treatment practices for 1960, secondard treatment for 1980, 2000, and 2020.

TABLE L-7(E) SUBREGION E - PRESENT AND FUTURE ORGANIC WASTE LOADS

PLANNING AREA NO. 18

Industrial,

Total

	Waste	Load, <u>a</u> / E.) 000		Load, b/	Waste Load, (P.E.) 000		
Year	Before Treatment	After Treatment <u>c</u> /	Before Treatment	After Treatment <u>c</u> /	Before Treatment	After Treatment <u>c</u> /	
1960	2,185	423	687	516	2,872	939	
1980	2,767	415	1,531	230	4,298	645	
2000	3,445	516	3,543	532	6,988	1,048	
2020	4,261	639	7,825	1,172	12,086	1,811	

Total population equivalents (PE) based on OBE projection of population.

Non-Industrial

- Projections made by multiplying (present, 1960, estimated gross waste load generated) x (OBE) projected output index). Based on total SIC Groups for the following 2 Digit Groups: 20, 22 26, 28, 29, 33, and 10-14.
- c/ Present treatment practices for 1960, secondard treatment for 1980, 2000, and 2020.

TABLE L-8(E)

KNOWN WATER POLLUTION PROBLEMS IN SUBREGION E

Water Body	Non- Indus <u>-</u> trial-/	Indus- trial	Thermal ^{2/}	Septic Tanks & Cesspools	Naviga- tion-	Acid Mine Drain- age	Runoff4/	Other ⁵ /
			AREA	17				
SUSQUEHANNA RIVER BASIN	<u>.</u>		<u></u>					
Susquehanna R. (N. Y.)	x	x	x					
Susquehanna R. (Pa.)	x	x	x			Х	•	
Tioga River						X		
Chemung River	x	X						
Lackawanna River	x	x				X		
W. Br. Susq. River	x	X				Х		
Juniata River								
			AREA	18				
CHESAPEAKE BAY DRAINAGE	<u>.</u>							
BASIN								
Chesapeake Bay	x	x	x		x			
Patuxent River	x						x	

 $[\]underline{1}$ / Includes wastewater from municipalities, institutions, and Federal installations.

 $\overline{2}$ / Includes thermal wastes from industry and thermal power plants.

 $[\]overline{3}$ / Includes all types of wastes from commercial, recreational, and Federal navigation.

 $[\]overline{4}/$ Wastewater containing: a) agricultural chemicals; and b) sediment from agricultural and urbanization or industrial operations.

^{5/} a. combined sewer systems b. nutrient enriched water c. low flow conditions d. suspect.

FIGURE E-2

MAP OF

SUBREGION E

WATER QUALITY PROBLEM AREAS

(Located in back of book)

VI - PRESENT AND FUTURE WATER QUALITY PROBLEMS

A. GENERAL

Of the more than 6800 miles of streams in Subregion E, some 1760 miles are seriously degraded by pollution. Stream reaches which currently have water quality problems are shown graphically in Figure E-2. Similar information is tabulated in Table L-8(E). The following is a discussion of the causes and extent of the major pollution problems in Subregion E.

B. NON-INDUSTRIAL AND INDUSTRIAL WASTES

In Area 17, three major river segments are degraded by municipal and industrial wastes. They are:

- Twenty miles of the Susquehanna River below Binghamton, New York
- 2. Ten miles of the Chemung River below Elmira, New York
- 3. Thirty miles of the Susquehanna River below Wilkes-Barre, Pennsylvania

Dissolved oxygen levels in these reaches have been as low as 1.0 $\,\mathrm{mg}/\mathrm{l}.$

In addition to the major stream reaches degraded, there are 24 tributary streams which are polluted by excessive organic waste loadings. These tributary streams are included in Table L-8(E).

Stream	Principal Problem Sources	Type of Pollution Problem
Payne Brook	Hamilton, N.Y.	organic
Chenango	Norwich, N.Y.	organic and chemicals
Tioughnioga River	Cortland, N.Y.	organic
Canisteo River	Hornell, N.Y.	organic
Lackawanna River	Scranton, Pa.	raw organic and chemicals
Spring Creek	State College, Pa.	nutrient
Marsh Creek	Wellsboro, Pa.	organic
Little Juniata	Altoona, Pa.	organic

Stream	Principal Problem Sources	Type of Pollution Problem
beream		
Beaverdam Branch	Altoona, Pa.	organic
Halter Creek and Frankstown Branch	Bare Div. Pulp & Paper at Roaring Springs, Pa.	organic and color
Frankstown Branch	W. Va. Pulp & Paper at Williamsburg	color
Kishacoquillas Creek	Lewistown, Pa. suburbs	heat and chemical
Letort Run and Conodoguinet Creek	Carlisle, Pa.	nutrient
Middle Spring Run	Shippensburg, Pa.	nutrient
Trindel Spring Run	Mechanicsburg, Pa.	organic
Plum and Conewago Creeks	Hanover, Pa.	organic and nutrient
0il Creek	Penn Township, Pa.	nutrient
W. Codorus Creek	P. H. Glatfelter Paper Co. at Spring Grove	organic and color
Codorus Creek	Residual wastes from P.H. Glatfelter and from York, Pa.	organic and color
Mill Creek	Dallastown, Pa.	organic and chemicals
Quittapahilla Creek	Lebanon, Pa.	organic and nutrient
Lititz Creek	Lititz, Pa.	organic
Conestoga Creek	Lancaster, Pa.	organic
Mill Creek	New Holland, Pa.	organic

Of the eight pulp and paper mills in Planning Area 17, four mills: P.H. Glatfelter at Spring Grove, Westvaco at Williamsport, Westvaco at Tyrone, and D.M. Bare at Roaring Springs, employ the kraft pulping process. The waste from this process exerts a significant biochemical oxygen demand as well as imparting a persistent color to the receiving stream.

The principal chemical discharges in Area 17 originate at Merck Company and Allied Chemical Company in the Danville, Pennsylvania, area. The Lebanon Chemical Company discharges to the Lebanon, Pennsylvania, municipal treatment plant causing overloads at the plants.

In Area 18, the largest non-industrial and industrial waste loads are concentrated in the Baltimore Metropolitan Region. The domestic wastes from Baltimore are treated to two plants, the Patapsco and Back River Treatment Plants. The Patapsco Plant provides primary treatment and discharges approximately 10 mgd of treated effluent to the Baltimore Harbor. The Back River Plant provides

secondary treatment for 160 mgd of sewage. The treated effluent from this plant is piped to the Sparrows Point Plant of the Bethlehem Steel Company where it is used for industrial process water.

At present, all of the sources of pollution entering the Baltimore Harbor are not known. The excellent facilities at the Harbor provide direct waterfront access to over 120 industries. Much of the pollution problem in the Harbor is connected with commercial navigation. Between 1964 and 1966, there were 20 incidents of oil pollution investigated in Baltimore Harbor.

Up-to-date water quality information is generally not available in Area 18 to identify all the water quality problems caused by non-industrial and industrial wastes. What information is available is located at the various government and academic institutions sampling the Bay. The Corps of Engineers is currently compiling a report on existing conditions of the Bay. Available information from the Federal and State agencies and academic institutions will be sought for use in this report.

C. COMBINED SEWER SYSTEM

The effects of combined sewer discharges are often masked by the heavy pollution load normally carried by the streams of the Subregion. In Area 17, 42 sewage service areas have combined sewer systems. These systems provide sanitary sewage collection service to over 50 percent of the area's population and, as a result, nearly two million population equivalents could be subject to by-pass around treatment plants during periods of high surface runoff. If the problem is not resolved by 2020, the stormwater by-pass through combined sewer could be as high as nine million population equivalents.

The extent of the combined sewer problem in Area 18 is not currently known.

D. SEPTIC TANKS AND CESSPOOLS

In Area 17, the disposal of wastes through septic tanks and cesspools does not cause a major pollution problem. The effective implementation of existing state regulatory laws should prevent future water quality degradation from this type of waste disposal.

The use of septic tanks and cesspools in Area 18 is complicated by the generally high water table. As a result, drain fields often do not function properly, and there is a possibility of contaminating the water supply taken from groundwater sources.

E. MINE DRAINAGE

Mine drainage causes the most widespread pollution problem in Area 17. More than 1200 miles of streams and rivers are severely degraded by this source. The principal streams affected are the West Branch, Tioga, Juniata, and tributaries of the middle Susquehanna River draining the anthracite coal fields.

Pennsylvania is actively enforcing mine drainage pollution laws which restrict the discharge of pollutants from active mines. This should keep the problem from worsening in the future. However, the major cause of the pollution is from inactive mines. To control the problem, an effective program for abating the discharges from abandoned mines must be implemented. It is estimated that complete abatement in Area 17 will cost approximately \$226 million. A program to abate mine drainage in the 12 watersheds where the results would be most beneficial will cost \$80 million in capital expenditures and \$11 million annually. This cost is partly borne under the Pennsylvania statewide Project 500; a \$500 million program which is already effectively abating the discharge from abandoned mines.

F. THERMAL SOURCES

There is currently only one known stream reach in the Subregion where thermal discharges cause a violation of water quality standards. The source of this discharge is the electric power plant on the West Branch near Shawville, Pennsylvania. This reach of stream is also badly degraded by mine drainage, and consequently, the thermal barrier is not a present threat to migratory fish.

The potential for thermal pollution problems in the Subregion are enormous. Large electric power generating plants are planned for the lower reaches of Area 17 and around the Chesapeake Bay. The states involved are aware of the potential thermal pollution effect these plants pose and are generally requiring some form of forced cooling system before discharge permits are issued. Due to the large size of some of the proposed plants, the amount of water evaporated to the atmosphere during cooling could cause water supply shortages during the low flow summer months.

G. RECREATIONAL AND COMMERCIAL NAVIGATION

Both recreational and commercial navigation in Subregion E are confined primarily to Area 18. The Chesapeake Bay is an important commercial navigation lane, and the shipping activity often results in local nuisance conditions from oil spills and overboard waste disposal. Also associated with commercial navigation is the disposal of dredged material into the Bay. The deposition of this material into the deeper trenches of the Bay could adversely alter the

hydrology and ecology of the Bay. The C and D Canal is currently being widened and deepened. Since there is a significant net outflow of fresh water from the upper end of the Bay through this Canal, an increase in the dimensions will permit additional fresh water losses. The exact impact of this loss on the ecology of the Upper Bay is not known. The disposal of dredge material in marshy areas is encroaching on some of the most important waterfowl feeding and breeding grounds in the country.

The waters of the Chesapeake Bay are used extensively for recreational navigation. Water quality problems associated with this use, although locally significant where pleasure boats concentrate, are not considered a widespread problem in the open waters of the Bay.

H. RURAL AND URBAN RUNOFF

Rural and urban runoff pollution enter the waters of the Subregion from non-point sources and, as such, are difficult to associate with a particular pollution problem area. Nutrients and pesticides contained in the farm runoff in the lower reaches of Area 17 and in Area 18 are suspected to be contributing to the background nutrient and pesticide levels. Also, salt and organic material from urban areas washed into the waters of the Subregion during storms generally lower the water quality throughout the Subregion. More definitive studies are needed to assess the magnitude and to define feasible alternatives for controlling this type of pollution.

I. OCEAN DISPOSAL

Ocean disposal is not a problem in this Subregion.

J. CONSTRUCTION ACTIVITIES

The Chesapeake Bay acts as a huge sediment trap for a drainage area of some 64,000 square miles. A large percentage of the sediments that enter the upstream tributaries are eventually deposited in the Bay. While existing data does not permit an exact determination of the amount of sediment being contributed to the Bay, it has been estimated as high as 8 million tons per year. The Susquehanna (600 thousand tons per year) and the Potomac River (2.5 million tons per year) transport the largest quantities of material to the Bay. It is estimated that the sediment contribution of the Susquehanna River to the UpperBay would be 1.7 times as great were it not for the deposition which takes place in the reservoirs along the lower course of the River. Sediments brought to the Bay by the major rivers consist primarily of silt and clay particles with minor components of sand.

The bulk of the material transported by streams entering the Bay is deposited in the estuaries of the stream as they enter the Bay. This deposition interferes with shipping channels and makes dredging necessary. The subsequent disposal of the dredge material constitutes a threat to valuable wetlands and, when the dredged material contains organic and toxic substances, a pollution problem is created.

U.S. Geological Survey sediment-discharge measurements indicate that some 3 million tons of suspended sediment are carried annually by the Susquehanna River. A large percentage of this material is deposited in the reservoir pools of the power dams in the lower reaches of Area 17. In Area 17, the highest sediment yields occur in the drainage areas disturbed by mining activities. in other coal mining areas of the country indicate that sediment yields from strip-mined coal land can be as much as 1,000 times that of forested land. Coal refuse banks also contribute to the sediment problem. In the anthracite fields there are 800 refuse banks that occupy a surface area of over 12,000 acres and contain 910 cubic yards of refuse material. The sediment produced from over 100,000 acres disturbed by mining operations in Area 17 must be controlled through land reclamation and revegetation measures. Also, according to Department of Agriculture estimates, soil erosion is the dominant problem of 3.2 million acres of the 4.2 million acres of cropland in the Area. Land treatment is needed and feasible for the protection and improvement of 2.3 million acres.

Land under forest cover has a sediment contribution rate of roughly 100 tons/sq. mi./year; while for lands that have been disturbed by agriculture, urban development, and construction activities, the rate might be as high as 400 to 800 tons/sq. mi./year.

VII - POLLUTION CONTROL ALTERNATIVES

A. SOURCE CONTROL

The most effective method of protecting the water quality of the Subregion is to prevent polluting material from entering the waters. This can best be achieved by the control of the pollutant at the source. Source control would be especially effective in preventing the formation and subsequent discharge of mine drainage pollution. It is estimated that from 20 to 70 percent of the mine drainage originating in this Subregion could be eliminated by appropriate preventive measures. The effectiveness of the preventive measure depends on the topography and geology of the area as well as the type of mining employed. Preventive measures which would be generally applicable throughout the Subregion are restoration of surface drainage, mine sealing, surface sealing, recontouring, and reforestation of disturbed areas.

Probably the only feasible way to control non-point source pollution, such as rural and urban runoff, is by employing preventive onsite measures. Erosion control measures, such as crop rotation, terracing, and strip planting, have reduced soil loss by as much as from 60 to 90 percent. Erosion not only depletes the required plant nutrients from the soil, but when these nutrients find their way into the water, they contribute to the eutrophication problem throughout the Subregion. Prudent use of chemical fertilizers and pesticides coupled with erosion control would help to diminish pollution from these sources.

The volume and strength of the waste produced in the manufacture of a product often depends upon the process being used. This is particularly true to the paper industry, one of the major polluters in the Subregion. The acid sulfite pulping process used in older kraft paper mills relies on calcium bisulfite for the digestion of wood chips. This process does not lend itself to water reuse or chemical recovery. New mills are using either magnesium, aumonium, or sodium base bisulfite; all of which have the advantage of producing a spent liquor that is amenable to by-product recovery and water reuse. All industrial plants in the Subregion should be encouraged to re-examine their current manufacturing processes and employ measures that would decrease the waste produced and increase water reuse. As new investments are made in manufacturing plants, they should be required to incorporate the most up-to-date manufacturing processes to minimize water use and waste production.

B. TREATMENT ALTERNATIVES

Even with the implementation of all feasible source control measures, there will still remain wastes that must be treated before

they are discharged to receiving waters. There are 202 sewage service areas in Area 17 and 39 in Area 18 that currently provide less than secondary waste treatment. All of these areas should provide a minimum of 85 percent BOD_5 removal by 1980. Also, there are 48 major pollution sources in the subregion where treatment levels in excess of secondary treatment will be required. These areas are:

Binghamton, N.Y.

Hamilton, N.Y. Elmira, N.Y. Hornell, N.Y. Hazelton, Pa. State College, Pa. Lock Haven, Pa. Altoona, Pa. Roaring Springs, Pa. Shamokin, Pa. Carlisle, Pa. Penn Township, Pa. Red Lion, Pa. Fredericksburg, Pa. Annville, Pa. Ephrata, Pa. Lancaster, Pa. Baltimore, Md.

Cortland, N.Y. Endicott, N.Y. Corning, N.Y. Scranton, Pa. Shenandoah, Pa. Bellefonte, Pa. Wellsboro, Pa. Tyrone, Pa. Williamsburg, Pa. Shippensburg, Pa. Mechanicsburg, Pa. Spring Grove, Pa. York, Pa. Lebanon, Pa. Elizabethtown, Pa. Lititz, Pa. New Holland, Pa.

In Area 17, low flow augmentation is a possible alternative to high level BOD removal for meeting water quality objectives. Both physical and economic factors must be evaluated in order to determine which alternative, or mix of alternatives, would be applicable to meet water quality objectives in each reach of watercourse. Due to the lack of reservoir sites, low flow augmentation is not considered a feasible alternative to high level treatment in Area 18.

C. STUDY NEEDS

In addition to the North Atlantic Water Resources Study, there are other interagency water resources studies recently completed which include all or portions of Subregion E. The major ones are the North Atlantic Water Supply Study, the Appalachian Regional Water Resources Study, and the Susquehanna River Basin Comprehensive Water Resources Study.

The date collected during these studies are the basis for defining current water quality control needs and to establish a workable framework for meeting future needs. Also, the officials of all the States in Area 17 are acutely aware of the water quality control

needs and are working diligently toward their solution. Water pollution control programs for Area 17 are probably at a more advanced stage of development than most Areas in the eastern United State; however, there are important problems that remain unresolved and will require additional study effort. The major problems in Area 17 which will require additional study are:

- 1. Mine Drainage What is the most feasible method of treating the pollution? Who is legally and fiscally responsible for abating the pollution from inactive and abandoned mines?
- 2. Thermal Pollution What are the long-range effects of thermal discharges?
- 3. Chesapeake Bay Relationship How will the flow regulation and waste discharges in Area 17 affect the hydrology and ecology of the Chesapeake Bay?
- 4. Financial Impact What capability exists for paying for water resource programs, and what will be the financial impact of such programs?

There are more than 1,450 known studies which deal with the Chesapeake Bay. However, these studies are mostly outdated and often limited to small areas and none deal with a coordinated approach to the overall problems of the Bay. There are data gaps in basic knowledge about water quality problems in Area 18. Water inventories are incomplete or outdated, water sampling data is for localized areas, and the long-term effects of such pollutants as nutrients and heat are unknown for a body of water as large as the Chesapeake Bay.

Other than the comprehensive water resource study conducted in the Patuxent River Basin, studies in Area 18 have been very localized and address only a particular problem. In 1965, the Corps of Engineers was authorized to perform a comprehensive evaluation of the entire Bay. The construction of a physical model of the Bay was included in the authorization. Due to the lack of funds following authorization, little progress was made on the study. However, the study is now being funded and the final design of the model is nearing completion. Because of the complex nature of it Bay and the many interrelated factors that affect it, a physical model is being constructed to provide a tool to observe and analyze certain phenomena that take place in the Bay. The advent of high speed computers will allow the application of mathematical modeling techniques to supplement the physical model. Some of the specific needs to which a study of this kind should address itself are:

1. Conduct studies to determine the source and amount of nutrient introduced to the Bay and to determine the current level of eutrophication in the Bay.

- 2. Determine the effect of diversions from the Susquehanna River from the Upper Bay via the C and D Canal on the hydrology and ecology of the Bay.
- 3. A complete municipal and industrial waste source inventory.
- 4. Develop a data gathering and data retrieval system for the entire Bay.
- 5. Evaluate the effect of projected waste discharges on the water quality of the Bay through the application of mathematical modeling techniques.
- 6. Define natural salinity patterns and determine the causes of salinity variations in these patterns and the effects the variations have on the ecology of the Bay.

D. OTHER NEEDS

1. Legal

The Susquehanna Basin Compact has been approved by the legislature of the States of New York, Pennsylvania, and Maryland. sequently the Congress of the United States approved the Compact and the President signed it, creating the Susquehanna River Basin Commis-The mechanism established in PL 91-575 should provide an effective means by which water resource development in the Susquehanna River Basin will proceed in an orderly and productive manner. A similar compact to provide for comprehensive management for the water resources of the Potomac River Basin would require approval by the Federal Government and the States of Maryland, Pennsylvania, Virginia, and West Virginia. Thus far, Maryland and Virginia have approved the Potomac River Compact proposal. The Susquehanna and Potomac Compacts should provide a legal mechanism to assure adequate fresh water inflow to the Chesapeake Bay for maintaining salinity balances essential to the Bay's biological productivity. The State of Maryland is currently considering the need for legislation to regulate the use of Bay waters for cooling water purposes. There appears to be a growing need for this type of initiative to control the increasing demands on tidal waters of the Bay in addition to regulating its fresh water inflows.

2. Manpower

As is true in other subregions in the NAR Area, the need in Subregion E for well-trained personnel to operate the required treatment facilities in acute. The ability of a treatment facility to achieve design efficiencies is dependent upon the skill and knowledge of the operator.

3. Research and Development

The two most pressing research and development needs specific for Subregion E are (a) to find a feasible and economic way to prevent or otherwise eliminate mine drainage pollution, and (b) to better define the threshold limits and ultimate effects of eutrophication on the Chesapeake Bay. The other research and development needs discussed in Chapter I of this Appendix generally apply to Subregion E.

4. Public Support

In the final analysis, the residents of the Subregion must decide what use is to be made of their resources. Whether or not the decision they reach is in the best interest of the majority of the residents depends on how well they are informed of the relevant facts concerning the environment and the consequences of their decision, or indecision. In studies like the NARS, and in subsequent studies, every effort should be made to keep the public informed, to stimulate their interest, and to enlist their support for water resource planning and development. The environment, from which everyone in the Subregion derives his existence, has been or is being destroyed by improper utilization. Much of past damage has been allowed to happen because of public apathy or the shortsighted desire for quick and easy monetary gain. Many of the environmental problems we now face in Subregion E are the legacy of past industrialization. By the planning and actions we take today, we must insure that similar changes cannot be leveled at our efforts. The public must be made aware of the impending environmental problems that are threatening their water resources. The public's desires, as expressed through their elected representatives, will help shape the course of water resource and environmental development in the Subregion.

5. Financial

Estimates of the financial investment required for water quality control in Subregion E have been prepared for the design years 1980, 2000 and 2020, and are presented in Table L-9(E). These costs represent the capital investment that would be needed to build secondary and advanced wastewater treatment facilities capable of treating projected waste loads for the target years. In practice wastewater treatment facilities are sized to accomodate the projected growth in waste load over a 20 to 25 year economic plant life. This, plus the actual timing of plant construction, the rate of physical obsolesence and salvage value, will determine actual expenditures over the study period. Operation and maintenance costs and the cost of collection systems and sludge disposal are not included in the cost estimates. The cost presented in Table L-9(E) should serve only to indicate the order of magnitude of the financial investment needed in Subregion E for water quality control and to serve as a common base for comparison with other Subregions. They are not intended to

replace estimates developed as a result of detailed engineering studies for specific municipalities or industries.

	Estimated	Estimated Addi-	
	Cost of	tional Cost of	
	Secondary _b /	Advanced Waste	d/
Year	Treatment ^D /	Treatment ^C /	Other Cost <u>d</u> /
	PLANNING	AREA NO. 17	
1980	376,000,000	40,400,000	
2000	606,000,000	64,900,000	
2020	986,000,000	106,000,000	
	PLANNING	AREA NO. 18	
1980	240,000,000		
2000	390,000,000		
2020	675,000,000	72,000,000	
	SUBREG	GION TOTAL	
1980	616,000,000	40,400,000	
_, 00	,,	, ,	
2000	996,000,000	64,900,000	
2020	1,660,000,000	178,000,000	

- a/ For general purpose planning only. Based on 1960 dollars. Costs not to be applied to any individual situation.
- $\underline{b}/$ Based on treating organic waste loads of both industrial and domestic origin. Treatment is considered to be 85% removal for the year 1980 and 90% for the years 2000 and 2020.
- <u>c</u>/ Treatment which would remove, in addition to 95% Biochemical Oxygen Demand and 98% suspended solids, up to 98% of nutrients and up to 95% of other materials not removed by conventional treatment methods.
- d/ These costs are, where known, estimates for combined sewer overflows control and acid mine drainage control.

VIII - POLLUTION CONTROL PROGRESS

A. STATE

The State officials of the Subregion are aware that the waters of the Subregion are a valuable, though not inexhaustable, resource; and that these resources must be protected and developed in order that present and future requirements will be met. All of the States in the Subregion have established interstate water quality standards and have developed an implementation plan for achieving these standards. In addition, New York, Pennsylvania, and Maryland have established interstate water quality standards and have developed an implementation plan for achieving these standards. In addition, New York, Pennsylvania, and Maryland have established standards for the major intrastate streams. Pennsylvania's recognition of the seriousness of mine drainage pollution led to the passage of strong legislation regulating mining operations in the State. During the 1966 session, the Pennsylvania legislature passed a \$500 million bond issue which was subsequently approved by the voters. This provides \$100 million for sewage treatment plant construction grant purposes and \$150 million for initial mine drainage pollution abatement action. Although this appropriation is for the mine drainage problem in the entire State and will cover only a small fraction of the cost of needed abatement in the Subregion, it shows a firm commitment by the citizens of Pannsylvania to abate this type of pollution. In 1965, New York initiated a six-year comprehensive program and passed a \$1.7 billion bond issue for the elimination of water pollution in the State.

B. FEDERAL

The Water Quality Act of 1965, as amended, contains the authorization for Federal involvement in efforts to eliminate pollution and enhance water quality in the interstate waters of the Nation. In compliance with stipulations of the Act, all the States in the Subregion have submitted water quality standards which have been approved by the Federal Government. Also, the Act established the mechanism through which the Federal Government would share in the cost of financing treatment facilities. Up to January 1968, 92 new waste treatment plants in Area 17 received money under the Act and 169 plants underwent renovation or expansion. In all, over \$147 million have been expended on treatment facility construction, of which \$30 million have been from Federal grants.

C. STATE AND FEDERAL

A number of comprehensive water resource studies are either underway or planned involving both State and Federal efforts. In addition

to the NAR Study, the Coordinating Committee for the Susquehanna River Basin has completed a study evaluating all water related resources of the entire basin. Portions of the Susquehanna Basin have also been studies under the authority of the Appalachian Redevelopment Act of 1965. A study of the Chesapeake Bay including the construction of a physical model is underway. Progress on this study has been hampered by the lack of adequate funding, however, funds are now available and the study is underway. The State Legislatures of Maryland, Pennsylvania, and New York, compact for the Susquehanna River Basin. This compact will be the basis for Federal/State cooperation in the development of water resources of this basin.

The State legislatures of Maryland, Pennsylvania, and New York have approved an interstate compact for the Susquehanna River Basin. The Congress of the United States has approved the Compact and it will be the basis for Federal-State corporation in the development of the water resources of this Basin.

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY APPENDIX L

WATER QUALITY AND POLLUTION

CHAPTER 7

SUBREGION F

ENVIRONMENTAL PROTECTION AGENCY WATER PROGRAMS OFFICE May 1972

CHAPTER 7

SUBREGION F

I. INTRODUCTION AND SUMMARY OF FINDINGS

Chapter 7 is a report on present and projected water quality and pollution conditions within Subregion F of the North Atlantic Regional Water Resources (NAR) Study Area. The Subregion includes those portions of Maryland, Virginia, West Virginia, Pennsylvania, and District of Columbia drained by the Potomac, Rappahannock, York, and James Rivers. Contiguous areas along the western shore of the Chesapeake Bay are also included within the Subregion.

The Chapter is intended to provide a broad-based analysis of the water quality problems in Subregion F and to furnish general appraisals of the probable motive, extent and timing of measures for their solution. The material presented in this Chapter is based on general relationships, reasoned approximations, available data, and judgment of experienced planners. The material as presented should be used in the context of a framework study and should be considered preliminary or reconnaissance—type in nature.

SUMMARY FINDINGS

- 1. Subregion F is the southern most division of the NAR Study Area and ranks second among the six NAR subregions in size with a land area of 31,240 square miles (about 18 percent of the entire Region's land area).
- 2. The Subregion's 1960 population of 4,865,818 ranks the Subregion fifth in population density with 156 persons per square mile. Population of the Subregion is projected to increase to 12,562,200 by 2020—an increase of 158 percent. The population density of 402 persons per square mile in 2020 will maintain the fifth—ranked position of the Subregion within the NAR Study Area. In terms of the total employment, Subregion F has the lowest portion of workers engaged in manufacturing of all the six subregions. The relative proportion of manufacturing workers will decrease in the future. Per capita personal income (\$2,133 in 1960) within the Subregion is the fourth highest of the six NAR Subregions. The expected increase of 517 percent in per capita personal income by 2020 is the third largest in the study area.
- 3. Projections indicate that Subregion F will maintain its relative economic position through the year 2020.
- 4. The water resources of Subregion F are utilized for a wide variety of purposes. These uses may be categorized as municipal and

industrial water supply, recreation, commercial fishing, power generation, irrigation, and commercial navigation. Of these uses, municipal and industrial water supply accounts for 1308 mgd (million gallons per day) of water use in 1965. By 2020, this use is projected to increase to 5559 mgd. Continued increase in demand for water-based recreation is expected, particularly in the vicinity of major urban areas. Present and future abuses of the Potomac and James River estuaries may prove to be detrimental, and with evidence of deterioration of these valuable commercial fishing areas. Heated effluents from power generating facilities without proper control will pose a threat to other present and future water uses.

- 5. Waste sources in Subregion F are varied and numerous. The most significant result from industrial and non-industrial activities, rural and urban runoff, recreation, and commercial navigation. Industrial and non-industrial sources of organic waste loads presently contribute about 3 million P.E. (population equivalent) of BOD (Biochemical Oxygen Demand) to the surface waters of the Subregion. Non-industrial sources account for approximately 52 percent of the loading. The paper and chemical industries together contribute over 90 percent of the total industrial organic load. Mine drainage pollution has adversely affected more than 170 miles of streams in the upper drainage area of the North Branch of the Potomac River.
- 6. Future organic waste generation will increase to 16.3 million P.E. in 1980, 33.5 million P.E. in 2000, and 67.9 million P.E. in 2020. Secondary treatment of all organic waste generated with result in an approximate 85 percent reduction in BOD loading from the anticipated waste. By the year 2020, industrial waste loads are projected to be over 80 percent of the total organic waste load. As set by the Potomac River-Washington Metropolitan Area Enforcement Conference, operational advanced waste treatment for nitrogen and phosphorus removal will generally be required by July 1973 for eight sewage discharges from municipalities and six sewage discharges from Federal installations presently discharged into the Potomac River and tributaries in the area of Washington, D.C.
- 7. It is estimated that the cost of providing secondary treatment facilities for the waste loads anticipated in the design years 1980, 2000, and 2020 will be \$193 million, \$1,887 million, and \$3,834 million, respectively.
- 8. Water quality planning studies are presented in various stages of development within Subregion F. The Appalachia Water Resources Study covering portions of the Subregion has been published. The interagency study of the Chesapeake Bay Drainage Basins has been initiated. Comprehensive Water Resources Plans for each of the major drainage basins within Virginia are now being prepared by the Division of Water Resources, Commonwealth of Virginia, Department of Conservation and Economic Development. Active pollution abatement programs are conducted by each of the states within Subregion F.

Federal, State, and local funds are utilized to implement worthwhile water pollution abatement programs. Additional pollution abatement measures brought about through responsible pollution abatement action programs are needed to achieve present and future water quality objectives.

FIGURE F-1

MAP OF

SUBREGION F

LOCATION AND BOUNDARIES

(Located in back of book)

TABLE L-1(F)

SUBREGION F - PLANNING AREAS

Planning Area Number	Grouping of Whole Counties in the Planning Area	Major River Basins Within the Planning Area
19	Fulton, Pa. Franklin, Pa. Adams, Pa. Pendleton, W. Va. Hardy, W. Va. Grant, W. Va. Hampshire, W. Va. Mineral, W. Va. Morgan, W. Va. Berkley, W. Va. Jefferson, W. Va. Garrett, Md. Allegany, Md. Washington, Md. Frederick, Md. Montgomery, Md. Prince George, Md. Charles, Md. St. Marys, Md. Augusta, Va. Rockingham, Va. Page, Va. Shenandoah, Va. Warren, Va. Clarke, Va. Frederick, Va. Loudoun, Va. Fauquier, Va. Fairfax, Va. Prince William, Va. Arlington, Va. Stafford, Va. King George, Va. Westmoreland, Va.	Potomac River North Branch South Branch Shenandoah River
19	District of Columbia	
20	Rappahannock, Va. Madison, Va. Culpeper, Va. Orange, Va. Louisa, Va.	Rappahannock River York River

TABLE L-1(F) (Continued)

Planning Area Number	Grouping of Whole Counties in the Planning Area	Major River Basins Within the Planning Area
20	Spotsylvania, Va. Hanover, Va. Richmond, Va. Essex, Va. King and Queen, Va. King William, Va. Northumberland, Va. Lancaster, Va. Middlesex, Va. Gloucester, Va. Mathews, Va.	
21	Highland, Va. Bath, Va. Allegheny, Va. Craig, Va. Botetort, Va. Rockbridge, Va. Amherst, Va. Nelson, Va. Albermarle, Va. Fluvanna, Va. Buckingham, Va. Appomattox, Va. Goochland, Va. Powhatan, Va. Greene, Va. Cumberland, Va. Prince Edward, Va. Nottoway, Va. Amelia, Va. Chesterfield, Va. Henrico, Va. New Kent, Va. Charles City, Va. James City, Va. Prince George, Va. Surry, Va. Nansemond, Va. Isle of Wight, Va.	James River

TABLE L-2(F)

SUBREGION F - MAJOR RIVERS AND TRIBUTARIES

River Basin Bay Area	Tributaries	Drainage Agea (square miles)	Length (miles)
<u> </u>			<u></u>
	Planning Area No. 19		
Potomac River		10,700	400
	North Branch	1,328	102
	South Branch	1,488	135
	Shenandoah River	3,054	224
	Monocacy River	970	81
	Planning Area No. 20		
Rappahannock Ri		2,715	184
	Rapidan River	693	85
	Hazel River	351	44
	Mountain Run	125	29
	Rock Run	107	6.9
York River		2,661	30
	Mattaponi	912	102
	Pamunkey	1,474	91
	Planning Area No. 21		
James River		10,102	434
	Jackson River	901	96
	Maury River	839	80
	Buffalo River	153	29
	Rockfish River	247	40
	Hardware River	138	21
	Rivanna River	770	78
	Willis River	278	56
	Chickahominy River		83
	Appomattox River	1,600	152
	Nansemond River	219	34
Chesapeake Bay			180 miles long

180 miles long 3-27 miles wide

II - DESCRIPTION OF SUBREGION F

A. LOCATION AND BOUNDARIES

Subregion F is the southernmost division of the North Atlantic Water Resources Study Area and includes portions of the States of Maryland, Pennsylvania, West Virginia, and Virginia and the District of Columbia (See Map I). The Subregion is divided into Planning Areas designated as 19 (Potomac River Basin), 20 (York and Rappahannock River Basins), and 21 (James River Basin). The boundaries of the hydraulic subareas follow county political jurisdictions. Table L-1(F) lists the counties and major rivers in each planning area.

B. PHYSICAL FEATURES

1. General Hydrology

The Potomac and James Rivers, along with Chesapeake Bay into which all of the major rivers in the Subregion flow, are the dominant hydraulic features of the Subregion in terms of volume or flow, drainage, and surface water area. The tributaries, drainage areas, and length of the major rivers of Subregion F are listed in Table L-2(F). More detailed hydrologic information is presented in Appendix C.

2. General Geology and Topography

Subregion F includes five distinct physiographic provinces. They are from west to east: the Allegheny Plateau, the Ridge and Valley Province, the Blue Ridge Province, the Piedmont Plateau, and the Coastal Plain. the Allegheny Plateau, which contains the headwaters of the Potomac and James Rivers, is characterized by swift, flowing streams and narrow valleys flanked by high, steep hills. The stream valleys in the Ridge and Valley Province are generally broad and fertile and bounded by forested mountains.

The headwaters of the Rappahannock and York Rivers are located in the Blue Ridge Province, a narrow, mountainous belt which traverses the Subregion in a northeast direction. The summit of the Blue Ridge Province ranges from 1,200 to 1,500 feet above sea level.

The Piedmont Plateau, which lies east of the Blue Ridge Province, is characterized by rounded hills and flat-bottom valleys with elevations ranging from 800 feet above sea level along the western boundary to 200 feet above sea level at the Fall Line. The Fall Line, the point where the Piedmont Plateau merges with the Coastline Plain, is characterized by a rapid increase in stream gradient. The Potomac River drops 160 feet in the final 13 miles. The Fall Line for the James River is located near Richmond, Virginia, where the riverbed falls over 100 feet in about 10 miles.

Rivers and streams in the Coastal Plain generally are sluggish due to the moderate relief of the Coastal Plain. The Coastal Plain contains the tidal estuaries of the major rivers of the Subregion.

3. Climate

Subregion F is characterized by a humid, continental climate inland from the Coastal Physiographic Province and a humid, subtropical climate in the Coastal Plain and Piedmont Provinces. The humid, subtropical climate is most pronounced in the southern portions of the Subregion. The areas of the Subregion inland from the Coastal Plain have four well-marked seasons. The seasons are less distinct in the coastal-humid, subtropical areas than in temperate areas, and there is great variation in temperature and precipitation.

Temperature extremes range from +106 to -15 F. in the Coastal Plain and from +95 to -30 F. in the Appalachian Plateau. The temperature zones in the Subregion correspond roughly to the relative elevations of the different physiographic provinces of the Subregion and the distance inland from Chesapeake Bay and the Atlantic Ocean.

III - ECONOMY

A. AREAS

Subregion F (directly south of Subregion E), with 31,240 square miles, is the second largest NAR Subregion and is ranked fifth in population density with 156 persons per square mile (based upon 1960 population total of 4,865,818). The Subregion's population density will rise to 402 persons per square mile as the Subregion's population reaches 12,562,200 in 2020, and it will still rank fifth in population density within the NAR.

B. SELECTED ECONOMIC MEASURES

In the Subregion's three areas are 80 counties situated in the States of Pennsylvania, Maryland, West Virginia, and Virginia, plus the District of Columbia. Five SMSA's and 17 urban centers are contained in the Subregion. On the basis of manufacturing workers per 1000 persons employed, Subregion F had the lowest number, 162 in 1960, of all six Subregions; and by 2020 this number will decrease to 110, still giving this Subregion the lowest study area rank. In terms of selected industry workers per 1000 manufacturing employees, Subregion F occupies a stronger position in the study area. This Subregion ranked third in 1960 and will be third by 2020.

Two of the Subregion's three planning areas, namely areas 20 and 21, are composed of 45 counties from the State of Virginia. Area 19 consists of 35 counties that fall within four states, Pennsylvania, Maryland, West Virginia, and Virginia, and the District of Columbia. Subregion F's per capita personal income was \$2,133 in 1960, the fourth highest of the six NAR Subregions, and will increase to \$13,159 by the year 2020. This increase is the third largest both as a percent and in absolute terms of all NAR Subregions.

TABLE L-3(F)

SUBREGION F - SELECTED ECONOMIC MEASURES AND PROJECTIONS

ECONOMIC MEASURES	1960	1980	2000	2020
Population	4,865,818	6,873,200	9,439,500	12,562,200
Total Personal Income (000-\$58)	10,380,500	30,607,778	72,085,156	165,309,470
Per Capita Income (\$58)	2,133	4,453	7,636	13,159
Total Employment by selected industries	1,861,138	2,860,000	3,963,100	5,278,000
Agriculture + forestry + fisheries	78,220	53,100	38,200	27,100
Mining	4,762	2,400	1,900	1,600
Manufacturing	301,864	392,000	479,500	580,000
Food and kindred products Textile mill products Chemicals and allied products Paper and allied products Petroleum refining Primary metals Six Industry Sub-Total All other manufacturing	35,944 11,170 27,944 13,228 1,179 7,765 97,230	37,400 9,400 40,300 18,900 300 9,300 115,600 276,400	38,100 7,800 54,700 24,000 300 11,100 136,000	39,000 6,700 71,600 30,100 200 12,400 160,000
Ç	·	•	,	•
Armed Forces	172,086	178,600	178,600	178,600
All other employment	1,374,206	2,233,900	3,264,900	4,490,700

IV - PRESENT AND FUTURE WATER USE

A. GENERAL

Water resources of the Subregion are utilized for a wide variety of purposes ranging from aesthetic enjoyment to industrial cooling and processing. These uses are not always compatible. When one use is emphasized to the detriment of another use, a water quality or water supply problem may be created. Some of the more important current and projected water uses are discussed in this chapter.

B. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Municipal water supply systems in Subregion F serve a population of four million or 76% of the basin population. By 2020, 83% of the basin population will be served by public water supply systems. In 1965, 1308 mgd was used for municipal and industrial purposes. By the year 2020 total public supplied water will increase to 5559 mgd. More detailed water supply information may be found in Appendix R.

C. RECREATION

The extent of recreational use of waters within the Subregion is unknown but considered substantial. Recreational use of the Subregion in the present largely undeveloped state consists primarily of boating, fishing, camping, hunting, and aesthetic enjoyment. demand for water-based recreation in the Subregion has increased in the past and is projected to continue to increase rapidly in the future. The areas receiving the greatest pressure are those in the proximity of the greatest concentrations of population, such as the Potomac River and Estuary near Washington, D.C., and the James River, western shore of Chesapeake Bay, and Atlantic Shore near the Richmond-Norfolk area in Virginia. Other areas, which at present are relatively underdeveloped for intensive water-based recreation, particularly the York and Rappahannock Rivers, will experience heavy demand from urban areas in the near future. At the present time the use of available potential water-based recreational areas, especially in the Potomac and James River Basins, is restricted due to poor water quality and the lack of access to potential high intensity recreation areas.

D. COMMERCIAL FISHING

Commercial fishing in Subregion F is concentrated in the estuaries of the Potomac, James, and Rappahanock Rivers. Commercial fishing and oystering is of considerable importance in the James River Estuary, and the Rappahanock and York Rivers. The James Estuary is one of the most prolific producers of seed oysters on the Atlantic

TABLE L-4(F) $\label{eq:constraint} \text{SUBREGION F - PRESENT AND FUTURE WATER USE} \frac{1}{2} \frac{2}{}$

Water Body	Water Supply	Shell- fishing	Bathing	Fishing	Agric., Ind Navig. & Other
Legend	x = Preser	nt Use	o = Future	Use	
	Planning Planning	Area No.	19		
Potomac River Basin					
Potomac River	o	0	О	xo	хо
North Branch of Potoma	С				
River	0		o	o	О
South Branch of Potoma	С				
River				xo	xo
Shenandoah River	хо		О	ох	xo
Monocacy River	xo		o	хо	хо
	Planning	Area No.	20		
Rappahannock River Basin					
Rappahannock River	хо	xo	О	xo	xo
Rapidan River	xo			xo	xo
Hazel River				xo	xo
Mountain Run	xo			xo	xo
Rock Run			•	xo	xo
York River Basin					
York River		О	0	xo	xo
Mattaponi River		О	o	xo	хо
Pamunkey River		o	0	xo	xo
	Planning	Area No.	21		
James River Basin					
James River	xo	x	o	xo	xo
Maury River	xo		0	хo	xo
Buffalo River	xo			хо	хо
Rivanna River				xo	хо
Chickahominy River	xo		o	xo	xo
Jackson River	xo			xo	
Appomattox River	xo		0	xo	xo
Chesapeake Bay		хо	0	xo	xo

 $[\]frac{1}{2}$ / Water uses are for the stream in general and not for any specific reach. $\frac{1}{2}$ / Future uses are those called for in the water quality standards.

Coast with beds located in the estuary reported to be the best continual producing seed areas in the world. The primary types of fish and shellfish caught in the Bay are blue crab, oysters, menhaden, soft crabs, alewives, scup, swellfish, shad, herring, and seed oysters. The average weight of the 1960-64 landings was 94.5 million pounds, and the dockside value of the landing was 12.6 million dollars. Ten percent of Chesapeake Bay figures are included in this number.

There is considerable variation from year to year in the value and volume of the catch and in the types of fish and shellfish produced, mainly due to variations in weather conditions.

It would be a simple matter to procure witnesses to testify to a tale of great depletion in the Tidewater, Potomac, and James Rivers. It would be quite another matter, however, to procure facts with which to analyze or even verify such accounts. While the sketchy records available do not show a pronounced decline in production, the abuses to which the Potomac and James Estuaries have been subjected have proven extremely detrimental in other locations, and it may be only a matter of time before rapid deterioration becomes evident in either or both of the estuaries.

E. POWER GENERATION

There are 23 power generating plants in Subregion F; one is hydropower, and 22 are coal or oil fired steam generating plants. Two nuclear power plants are planned for Louisa and Surry Counties (Subareas 20 and 21). Their respective capacities will be approximately 1,600 and 1,630 megawatts. Much of the projected growth in power generated within the area will come from nuclear-fired steam generators with some new coal and oil units. In 1967, 3,884 megawatts were generated within Subarea 19; 375 megawatts in 20; and 2,696 megawatts in 21. Projections indicate that by 1980, 8,880, 860, and 6,160 megawatts will be produced, respectively.

F. IRRIGATION

Irrigation is expected to experience growth in the Subregion in future years, especially in Subarea 19, where the irrigation of fruits will increase. According to the Appendix I prepared by the Department of Agriculture, the gross seasonal irrigation requirements for 1980, 2000, and 2020 are 40,300 acre-feet, 54,700 acre-feet, and 48,700 acre-feet, respectively.

G. COMMERCIAL NAVIGATION

Hampton Roads, including the harbors of Norfolk, Newport News,

and Hampton, is the third busiest port in the United States. The excellent deep water facilities and overland transportation system make Hampton Roads a favorite port for both domestic and foreign commerce.

V - WATER QUALITY CONTROL

A. PRESENT WASTE LOADS

1. General

Industrial and non-industrial waste sources currently discharge approximately three million population equivalents to the waters of Subregion F. This represents about 43 percent of the total organic waste load generated in the Subregion. In addition to organic loading, the headwaters of the Potomac River also receive mine drainage pollution. Other sources of pollution, such as combined sewers, navigation, rural and urban runoff, and construction activities, also contribute to the pollution load of the Subregion. The following is a brief discussion of most significant sources of pollution in the Subregion.

2. Non-Industrial Waste Loads

The present non-industrial waste loads in Subregion F are summarized in Table L-5(F). A total waste load equivalent to the raw waste discharge of a city of 1,566,000 persons is currently being discharged into the surface waters of the Subregion from non-industrial sources. The waste discharge from the Washington Metropolitan area accounts for approximately 88 percent of the non-industrial waste discharged in Subarea 19; while the waste discharged into the estuary of the James River (from Richmond to Hampton Roads) accounts for approximately 88 percent of the non-industrial waste discharged in Subarea 21.

3. Industrial Waste Loads

Present industrial waste loadings, summarized by major types of water-using industries, are presented in Table L-6(F). As can be seen from this table, industrial organic waste discharges in the Subregion are equivalent to the organic wastes produced by a population of 1,445,000. In terms of population equivalents, the paper and chemical industries together contribute about 90 percent of the industrial organic waste load in the Basin. In addition to the organic material, the waste from these industries often contains inorganic material which is harmful to the aquatic population, add taste and color to the water, and otherwise generally degrade the quality of receiving waters.

4. Combined Sewers

No data is available to indicate the magnitude of the combined sewer systems in Subregion F.

TABLE L-5(F)

SUBREGION F - ESTIMATED PRESENT NON-INDUSTRIAL WASTE DISCHARGES*

*				DEGI	REE OF TRE	ATMENT				
Planning Area	Sub- Total	Unknown	None	Pri- mary	Inter- mediate	Secon- dary	Adv. Waste Treat.	Over- loaded; Outdated	Systems Not Chlori- nating	Combined Storm Sewer Systems
<u>19</u>										
No. of Systems	119		23	28	_	68	_			
Pop. Served (000)	2,140		13	265	_	1,862				
Waste Load Disch. Calc. P.E. (000)	888		26	328	-	534	_		·	
20										
No. of Systems	30		1	6	1	22	-	1	2 5	
Pop. Served (000)	66		1 2 2	4 3	1 17	43	-	1	5	-
Waste Load Disch. Calc. P.E. (000)	20		2	3	9	6	-	0.4	2	
21										
No. of Systems	64		12	23	-	29	-	-		-
Pop. Served (000)	1,097		30	932	-	135	-	-	-	
Waste Load Disch. Calc. P.E. (000)	658		29	609	_	20	-	-	-	_
Subregion Total	0.7.0		26	.	1	110		1	2	
No. of Systems	213		36 4.5	57 1 201	1	119	-	1 1	∠ 5	_
Pop. Served (000) Waste Load Disch. Calc. P.E. (000)	3,303 1,566		45 57	1,201 940	1 7 9	2,040 560	-	0.4	2 5 2	-

^{*} Non-industrial includes wastes from municipal, institutional, and Federal sources.

TABLE L-6(F)

SUBREGION F - ESTIMATED PRESENT INDUSTRIAL WASTES

SUMMARY

	Waste Load Before Treat	Number of Known	Water Use		Adequacy	of Treatme	nt	Waste Load Discharged
2 Digit SIC Group			(mgd)	None	Partial		Unknown	(Est. P.E. 000)
20 Food	262	49	7.4	10	28	4	7	72
22 Textiles	207	6	3.4	1	5			56
26 Paper	2,181	11	112.8	1	10			697
28 Chemicals	973	14	322.1	6	8			610
29 Petroleum	12	1	58			1		10
33 Primary Metals		1	0.5		1			
10-14 Mining								
Subregion Total	3,635	82	504.2	18	52	5	7	1,445

TABLE L-6(F)

ESTIMATED PRESENT INDUSTRIAL WASTES

SUBREGION F - AREA 19

	Waste Load Before Trea	Number of	Water Use		Adequac	y of Tre	eatment	Waste Load Discharged
2 Digit SIC Group	PE (000)	Known	(mgd)	None	Partial	Comp1.	Unknown	PE (000)
20 Food	131	42	6.0	10	21	4	7	35
22 Textiles	54	4	2.7	-	4			18
26 Paper	331	2	8.4	-	2			67
28 Chemicals	267	7	36.4	1	6			112
29 Petroleum	-							
33 Primary Metals	-	1	.5		1			<u>-</u>
10-14 Mining	-							-
Area Total	783	56	54.0	11	34	4	7	232

TABLE L-6(F)

SUBREGION F - ESTIMATED PRESENT INDUSTRIAL WASTES
AREA 20

	Waste Load Before Treat.	Number of Known	Water Use		dequacy of			Waste Load Discharged
2 Digit SIC Group	(Est.P.E. 000)	Sources	(mgd)	None	Partial C	omplete	Unknown	(Est. P.E. 000)
20 Food	-							•
22 Textiles	-							
26 Paper	150	1	24	1				150
28 Chemicals	53	1	30		1			39
29 Petroleum	12	1	58			1		10
33 Primary Metals	-							
10-14 Mining								
Area Total	215	3	112	1	1	1		199

TABLE L-6(F)

ESTIMATED PRESENT INDUSTRIAL WASTES
SUBREGION F - AREA 21

2 Digit SIC Group	Waste Load Before Treatment PE (000)	Number of Sources Known	Water Use (mgd)	None	Adequac Partial	y of Treat Complete	ment Unknown	Waste Load Discharged PE (000)
20 Food	131	7	1.4		7	_	-	37
22 Textiles	153	2	.7	1	1	_	_	38
26 Paper	1,700	8	80.4	-	8	-	-	480
28 Chemicals	653	6	255.7	5	1	_	_	459
29 Petroleum								
33 Primary Metals								
10-14 Mining								
Area Totals	2,637	23	338.2	6	17	_	<u>-</u>	1,014

6. Mine Drainage

The most significant acid pollution problem from coal mine drainage in the Subregion exists in the upper basin of the North Branch of the Potomac River in rural Appalachia. Of the 1328 square miles of drainage area in the North Branch of the Potomac River in Appalachia a total of 170 miles of streams are intermittently or continuously polluted by mine drainage. A total of 70 tons per day of mine drainage acidity is formed within the drainage area of which an estimated 33 tons per day is discharged to surface streams. Available information indicates that a substantial portion of the mine drainage contribution is attributable to inactive mining sources. Of the 170 miles of polluted streams about 130 are polluted on a continuous basis. The coal region of the North Branch of the Potomac River extends from its source to the area of Westernport, Maryland. this reach the North Branch receives acid mine drainage from at least eleven tributaries. Of these tributaries, Elk Run, Laurel Run, and Abram Creek contribute approximately 65 percent of the total measured net acidity load of 33 tons per day currently discharged to surface waters in the North Branch of the Potomac River Basin. The acid load, in combination with a heavy silt load and other harmful constituents of mine drainage, has disrupted the natural ecology of the North Branch and diminished the beneficial utility of the water.

7. Thermal Sources

Thermal electric power generating plants are the most significant source of thermal discharges within Subregion F. In 1968, 7929 megawatts of electricity were produced in the Subregion at 19 major plants.

The major distributors and producers of electrical power in the Subregion are the Virginia Electric and Power Company, Potomac Edison Company, and the Potomac Electric Power Company. It is estimated that the Virginia Electric and Power Company owns and operates plants that produce 62 percent of the 2 megawatts of installed capacity in the James River Basin. In the Potomac River Basin, the three power companies can produce in excess of 3,000 megawatts.

A total of 33 electric generating plants are located within the James River Basin, 20 of which are steam-electric generating facilities. Cooling water for thermo-electric use in the James River Basin is required at five steam generating power stations owned and operated by VEPCO. Total water use within the James River Basin for thermo-electric cooling purposes is estimated at 1.6 billion gallons per day.

There are two steam-electric power generating plants within the York River Basin. Virginia Electric and Power Company, Yorktown Plant has an installed capacity of 340,910 kilowatts and Chesapeake Corporations, West Point Plant, has an installed capacity of 44,250 kilowatts. All of the electric power produced by the Chesapeake Corporation Plant is consumed in their plant. There is no hydroelectric power generation in the basin. Approximately 220,000 gpm of spent cooling water with an average temperature rise of 8°C is discharged from the steam condensers at the Virginia Electric and Power Company downstream from Yorktown into the York River. The American Oil Company, Light Oil Refinery located downstream from the VEPCO steam-electric generating station results in the discharge of 45,000 gpm of spent cooling water at an average temperature rise of 10 to 15°F.

The only electric power generating plant now operating in the Rappahannock River Basin is that of the American Viscose Division of the FMC Corporation at Fredericksbury with an installed capacity of 21,500 kilowatts for power production for plant use. Water withdrawal by thermal electric generating plants in the Potomac River Basin was approximately 672,000,000 gallons per day in 1963.

8. Recreational and Commercial Navigation

The biggest navigation facility in the James River Basin is the Hampton Roads complex which includes the Norfolk Harbor, the Port of Newport News, Hampton Creek and the Channel of Phoebus to Deepwater in Hampton Roads, Virginia. In 1966, there were a total of 28,346 inbound vessels and 28,796 outbound vessels handling cargo in the Hampton Roads complex. A total of 53,000,000 short tons of commodities were transported through Hampton Roads in 1966.

Twenty-three marinas are located within the James River Basin providing a total of approximately 500 berths for pleasure crafts. Numerous docks for fishing and recreational carft are provided on the York River. In 1966, 4,487,395 short tons of goods were transported on the YorkRiver and its tributaries. A total volume of 209,338 short tons of commodities were carried on the Rappahannock River during 1966. During 1966, 44,325 vessel trips were recorded on the Rappahannock River.

9. Rural and Urban Runoff

Increasing use of chemical fertilizers and pesticides at agricultural areas have magnified the threat of pollution from land runoff in the Subregion. Urban runoff and combined sewers in the vicinity of Washington, D.C. and City of Richmond Metropolitan areas result directly or indirectly in nutrient enrichment and excessive turbidity of the Potomac and James River estuaries. Streams draining farm areas where soil conservation practices are not employed generally carry a heavy silt load. This is true particularly in the Monocacy and Shenandoah River Basins. Runoff from feed lots in the vicinity of Harrisonburg, Virginia, is believed to be partially responsible for high bacterial counts in the South Fork Shenandoah River.

10. Ocean Disposal

Ocean disposal is not a problem in this Subregion.

11. Construction Activities

Current and past construction activities have caused sediment Estimated sediment discharge figures in problems in the Subregion. the Potomac River Basin range from 75 tons per square mile of drainage area per year in the upper Shenandoah area to 560 tons per square mile per year in the urban Washington area. Suspended sediment entering at the head of the estuary of the Potomac River from surface runoff in the D.C. Metropolitan area and from sand and gravel operations contribute to the turbidity of the upper Potomac estuary. A considerable sediment load estimated to be approximately 2.5 million tons annually is transported to the estuary by tributary streams. Much of this load is delivered to the head of tide by the Potomac River, however, significant amounts also enter from the small tributaries which drain the Washington Metropolitan area. The average annual sediment discharge from the South Branch of the Potomac River is 107 tons per square mile or 157,000 tons per year. Comparable sediment figures for the North Branch are 138 tons per square mile or 225,000 tons per Hydrological conditions result in the suspended solids content of the two branches being quite comparable. Shore line erosion in lower tidal areas of the Potomac River basin is also evident. Monocacy River carries a heavy silt load which comes primarily from erosion of farm lands.

Sedimentation problems within the James River Basin are not generally severe. A serious erosion problem is, however, evident in the Virginia Beach area. Stabilization of the shore line has been required to protect from existing developments of beach erosion and wave attack and assure availability of beach areas for recreation. On the Rappahannock River, bank erosion is most serious along the tenmile reach immediately downstream from Remington between Fauquier and Culpeper counties. Some difficulties with bank erosion are experienced also on the lower Rappahannock River. Sedimentation problems within the York River Basin are confined largely to the mainstream of the York River within the lower basin. Deposition in the channel of the york presents a problem to navigation. Silting of the river channel is also a problem at West Point. The Soil Conservation Service in 1968 found the annual gross erosion rate in the York and The annual Rappahannock River Basins to be 512 tons per square mile. rate of sedimentation was determined as 192 tons per square mile. More than 75 percent of this erosion and most of the sediment is due to slope wash. Only a minor portion can be attributed to bank erosion.

A stream bank erosion survey of the York and Rappahannock Basins by the Soil Conservation Service and the Corps of Engineers estimates the annual cost of land treatment for control of slope erosion at \$365,000 and \$319,000 for the York and Rappahannock River Basins, respectively. Of the 4,840 bank miles surveyed in the york River Basin, 190 bank miles were found as moderately-eroded and 50 were found as seriously eroded. Some 40 miles of the 170 miles of stream bank surveyed in the Rappahannock River Basin were classed as seriously-eroded.

B. PROJECTED WASTE LOADS

Non-industrial and industrial waste loads were projected based on population and industrial productivity data developed by the Office of Business Economics, respectively. The population projections used are shown in Table F-3.

The projected productivity of the major waste-producing industries in the Subregion are shown below:

PROJECTED INDICES OF PRODUCTIVITY

Index of Productivity Design Year 1980 2020 2000 Base Area Year Area Area SIC 1960 19 20 21 19 20 21 19 20 21 Industry 2.01 1.98 2.06 3.72 3.52 7.12 6.40 6.58 Food 20 1.0 3.68 4.13 2.58 2.41 2.64 9.66 8.76 Textiles 22 1.0 1.74 5.12 4.68 9.96 Chemicals 28 1.0 2.35 2.72 2.27 4.60 6.00 4.79 8.81 12.47 3.28 2.92 3.51 10.91 9.06 12.39 27.65 21.90 31.96 Paper 26 1.0 29 1.0 4.08 3.92 12.60 13.45 33.21 42.77 Petroleum Primary 2.62 3.88 5.86 33 1.0 1.98 2.11 3.37 5.35 7.11 10.66 Metals

These production factors are based on a 1960 index of 1.0.

Based on the above data, the projected industrial and non-industrial waste loads for Subregion F were compared and are shown in Table L-7(F). Non-industrial waste loads presently account for about 52 percent of the total organic waste load contribution to surface waters in the Subregion. By the year 2020, non-industrial waste loads are projected to be less than 20 percent of the total organic waste loading.

TABLE L-7(F) SUBREGION F - PRESENT AND FUTURE ORGANIC WASTE LOADS

SUMMARY

	Non-Industrial Waste Load, a/ (P.E.) 000			strial, Load,b/	Total Waste Load, (P.E.) 000		
Year	Before Treatment	After Treatment ^C	Before Treatment	After Treatment	Before Treatment	After <u>Treatment</u> C/	
1960	3,309	1,558	3,635	1,445	6,944	3,003	
1980	6,873	1,030	9,413	1,412	16,286	2,442	
2000	9,439	1,390	24,023	3,532	33,462	4,922	
2020	12,562	1,847	55,332	8,023	67,894	9,870	

Includes waste loads from municipalities, institutions, and Federal installations.

Includes the waste loads from the six major water-using two-digit SIC groups.

This is considered to be the result of actual treatment practices carried out in 1960 and then secondary treatment for the entire population for 1980, 2000, and 2020.

TABLE L-7(F) SUBREGION F - PRESENT AND FUTURE ORGANIC WASTE LOADS

AREA 19

Industrial,

Waste Load, b

Total

Waste Load,

	(P.E	2.) 000		2.) 000	(P.E.) 000		
Year	Before Treatment	After Treatmentc/	Before Treatment	After Treatment ^c /	Before Treatment	After Treatment	
1960	2,140	880	783	232	2,923	1,112	
1980	4,434	665	2,011	300	6,445	965	
2000	6,338	950	5,066	759	11,404	1,709	
2020	8,627	1,294	10,700	1,560	19,327	2,854	

Non-Industrial

Waste Load, a/

a/ Includes waste loads from municipalities, institutions, and Federal installations.

 $[{]f p}$ Includes the waste loads from the six major water-using two-digit SIC groups.

c/ This is considered to be the result of actual treatment practices carried out in 1960 and then secondary treatment for the entire population for 1980, 2000, and 2020.

TABLE L-7(F)

SUBREGION F - PRESENT AND FUTURE ORGANIC WASTE LOADS

AREA 20

Industrial Waste Load, b/

Total

Waste Load,

	(P.E.) 000		(P.E.) 000		(P.E.) 000		
Year	Before Treatment	After Treatment	Before Treatment	After Treatment <u>c</u> /	Before Treatment	After Treatment ^c /	
1960	72	20	215	199	287	219	
1980	382	57	612	92	994	149	
2000	518	52	1,525	153	2,043	205	
2020	737	74	4,628	463	5,365	537	

Non-Industrial

Waste Load,

a/ Includes waste loads from municipalities, institutions, and Federal installations.

 $[\]overline{b}$ / Includes the waste loads from the six major water-using two-digit SIC groups.

c/ This is considered to be the result of actual treatment practices carried out in 1960 and then secondary treatment for the entire population for 1980, 2000, and 2020.

TABLE L-7(F) SUBREGION F - PRESENT AND FUTURE ORGANIC WASTE LOADS

AREA 21

	Non-Industrial Waste Load,a/ (P.E.) 000			strial _b / Load, <u>b</u> / L) 000	Total Waste Load, (P.E.) 000		
Year	Before Treatment	After <u>Treatment</u> c/	Before Treatment	After Treatment ^c /	Before Treatment	After Treatment ^C /	
1960	1,097	658	2,637	1,014	3,734	1,672	
1980	2,057	308	6,790	1,020	8,847	1,328	
2000	2,583	388	17,432	2,620	20,015	3,008	
2020	3,198	479	40,004	6,000	43,202	6,479	

a/ Includes waste loads from municipalities, institutions, and Federal installations.

Includes the waste loads from the six major water-using two-digit SIC groups.

This is considered to be the result of actual treatment practices carried out in 1960 and then secondary treatment for the entire population for 1980, 2000, and 2020.

FIGURE F-2

MAP OF

SUBREGION F

WATER QUALITY PROBLEM AREAS

(Located in back of book)

VI - PRESENT AND FUTURE WATER QUALITY PROBLEMS

A. GENERAL

Of the more than 6900 miles of streams in Subregion F, some 1500 miles are seriously degraded by pollution. Stream reaches within the Subregion which currently have water quality problems are shown graphically in Figure F-2. Similar information is tabulated in Table L-8(F). The following is a discussion of the causes and extent of the major pollution problems in Subregion F.

B. NON-INDUSTRIAL AND INDUSTRIAL PROBLEM AREAS

Raw, partially treated and treated waste loads from non-industrial and industrial waste load sources amount to 6.9 million P.E.'s is presently discharged to the inland and coastal waters of Subregion F. As a result, various reaches of surface waters within the Subregion are seriously degraded.

_	Principal	Type of			
Stream	Problem Sources	Pollution Problem			
York River	American Oil Co., VEPCO at Yorktown	Potential toxic conditions, heat			
Pamunkey River	Chesapeake Corporation at West Point	O r ganic			
Unnamed tributary of Pamunkey River	City of Gordonsville	Organic			
Mountain Run	City of Culpeper	Organic			
Poplar Run	Kentucky Flooring Company of Va.	Organic			
Rappahannock River	City of Remington	Organic			
Rappahannock River	City of Fredericksburg and Food Machinery Corp., American Vis- cose Division	Organic			
Jackson River	West Virginia Pulp and Paper Company at Covington	Organic and color			
James River	Lynchburg, Va., pulp and paper, chemicals	Organic, color, and chemicals			
James River	Richmond, Virginia	Organic, nutrients			
James River	Hopewell, Virginia, chemical industry	Organic, chemicals			
Appomattox River	Colonia Heights, Petersburg, Va.	Organic			
James River	Hampton, Newport News, and Norfolk area (stormwater and com- bined sewer overflows)	Organic			

Stream	Principal Problem Sources	Type of Pollution Problem
	a cc 11 W	Nutrients
Nansemond River	Suffolk, Va.	
Eastern Branch Elizabeth River	Port Chesapeake, Norfolk, Va.	Nutrients
Monocacy River	Frederick, Maryland	Organic, turbidity bacteria
North Branch Potomac River	Luke, Maryland	Acid mine drainage, Organic, bacteria
Potomac River	Washington, D.C.	Organic, bacteria, turbidity, nut- rients
Anacostia River	Washington, D.C.	Organic, nutrients, bacteria

Pollution problems within the Subregion are most critical in the upper Potomac River estuary in the vicinity of Washington, D.C., the Rappahannock River below Fredericksbury, the James River below Lynchburg and Richmond, and the Jackson River at Covington, Virginia.

Waste effluent discharged in the metropolitan area of the District of Columbia seriously reduced water quality in the Upper Potomac River estuary and minir tributaries. Deleterious effects attributable to these wastes include very high bacterial counts, high concentrations of organic materials, a low and sometimes depleted dissolved oxygen content, and high nutrient concentrations which bring about massive algae blooms. Low dissolved oxygen levels in the upper estuary is a continuing unsatisfactory condition. The Potomac estuary has had a long history of fish kills.

The principal organic waste loadings occurring in the Washington Metropolitan Area include the District of Columbia pollution control plant (80,300 lbs/day BOD), Arlington County (23,000 lb/day BOD), and Fairfax County (12,500 lb/day BOD). An estimated total wastewater flow of 348,000,000 gallons per day from a population of 2,480,000 persons in the Washington metropolitan area is discharged to the Poto-The wastewater loading results in an estimated load of mac River. 129,000 lb. of BOD, 52,000 lb. of nitrogen as nitrogen, and 64,000 lb. Of the total wastewater of phosphorus discharged into the Potomac. nutrient loading in the entire Potomac River Basin, approximately 75 and 80% of the phosphorus and nitrogen, respectively, orginate from wastewater discharges within the Washington, D.C. area. Since the late 1930's, the amount of phosphorus entering the Potomac from wastewater discharges in the Washington metropolitan area has increased about ten-fold. Nitrogen has increased about five-fold.

Eight major municipal wastewater treatment facilities discharge within the Potomac estuary. The treated discharges have a biochemical

TABLE L-8(F) SUBREGION F - KNOWN WATER POLLUTION PROBLEMS

Water Body	Non- Indus- trial	Indus- trial	Thermal	Septic Tanks & Cesspools	Naviga- tion	Acid Mine Drainage	Ag. & Urban Runoff	Other $\frac{1}{}$
			Planning	Area No. 19				
North Branch Potomac River	x	x				x		
Shenandoah R.	x	x					x	ъ
Potomac River	x	x			x		×	a,b
			Planning	Area No. 20				
York River		x			x			
Rappahannock R.	x	x			x			
			Planning	Area No. 21				
James River	x	x			x			a,b

^{1/} a combined sewer systems

b nutrient enriched water

c inadequate dilution d suspected problems, but not identified

oxygen demand (BOD) of 100,000 lb/day equivalent to the untreated sewage from 600,000 people. This loading is about six times the natural capacity of the estuary to assimulate oxygen demanding waste and maintain a dissolved oxygen average of 5 milligrams per meter.

In the lower estuary of the Potomac, water quality is generally satisfactory for most purposes. Occasional algae blooms and fish kills do occur within this region. There exists a few small isolated areas below waste outfalls within the lower estuary where commercial harvesting of shellfish is prohibited.

Over-enrichment of the tidal Potomac River by nitrogen and phosphorus is a problem of large magnitude during the warmer months and may eventually prove to be the largest single problem of pollution in the entire Potomac watershed. Threatened pollution of the Occoquan Creek watershed and reservoir looms as the most serious immediate single problem in the Virginia portion of the Potomac River Basin.

Serious water quality problems exist in the Rappahannock River below the populous Fredericksburg area. The discharge of untreated and partially treated municipal and industrial waste into the Upper Rappahannock estuary causes, during periods of low flow, zero dissolved oxygen levels and nuisance conditions which extend downstream from the City of Fredericksburg, a distance of 12 to 18 miles. Fish kills occur and the river becomes generally undesirable for most legitimate uses. The principal contributor to the problem is the Food Machinery Corporation, American Viscose Division which discharges approximately 30 million gallons per day of partially treated waste to the river. Above Fredericksburg, the Rappahannock River is generally of good quality for all water uses.

Presently, about one-third of the James River from its mouth at Hampton Roads upstream to Covington, a total of 360 river miles, is adversely affected by municipal and industrial waste to the extent that use of its water is restricted to some degree. Pollution of the James River is severe between Richmond and Brandon Point, a distance of 48 nautical miles. The sources are untreated non-industrial and industrial waste emanating from Richmond and Hopewell. During low flow conditions considerable difficulties are experienced by taste and odor conditions in the City of Richmond's water supply. The principal cause of this problem is attributed to excessive algae growth resulting from high concentrations of nutrients in the James River during the low flow periods. In the James above Richmond, there are several possible sources of nutrients, agriculture land drainage and municipal waste discharges, upstream being the most significant.

In the upper James River Basin, waste resulting from pulp and paper production account for a large part of the pollution problem, especially in the Covington and Lynchburg areas. The most critical downstream areas with regard to water quality exhibit recurring conditions of depleted or neatly depleted dissolved oxygen content. Three pulp and paper mills are located in the upper basin—one in Covington and two in the Lynchburg area. Occasional light fish kills have been experienced in the James River below Lynchburg, and complaints have been received regarding tainting of fish flesh. Biological studies indicate the evidence of moderate to heavy stream degradation within this reach of the river. Treated industrial waste from the West Virginia Pulp and Paper Company and municipal waste discharges within the area of Covington degrade water quality in the Jackson River down—stream from Covington to Iron Gate, Virginia.

Most of the waste treatment facilities in the James River estuary area provide only primary treatment with strictly enforced, high chlorination standards to protect the shellfish industry. In the estuarine portion, hundreds of acres of oyster beds are condemned for direct harvesting. The industry cannot exist in close proximity to concentration of human activities. Substantial improvements by effluent chlorination have been made insofar as shellfish harvesting is concerned in the Hampton Roads and James River waters. Tributary waters, however, have become increasingly worse as a result of the rapidly growing population of the area.

C. COMBINED SEWER SYSTEMS

In the Subregion, sewage service areas have combined sewer systems.

Combined sewer discharges from the City of Richmond and Washington, D.C. metropolitan area are one of the major problems of uncontrolled pollution of the James River and Potomac estuaries. Stormwater and combined sewage discharges are also major sources of water pollution in the lower estuarine portion of the James River in the area of Hampton, Newport News, and Norfolk.

Bypassing of raw sewage flows during wet seasons as a result of storm and groundwater infiltration of sanitary sewer systems lowers treatment plant overall effectiveness in municipalities throughout the Subregion.

D. SEPTIC TANKS AND CESSPOOLS

The disposal of wastes through septic tanks and cesspools does not present a major pollution problem in the Subregion. The effective-implementation of existing state regulatory laws should prevent future water quality degradation from this type of waste disposal.

The future growth of the lower York County will depend greatly on provision of adequate public sewerage systems. The area is

presently served by the septic tanks even though the soil within the area is generally not suitable for subsurface disposal systems.

E. MINE DRAINAGE

Coal mining activity, which in the past has gone uncontrolled. has caused extensive damage to the land and water resources. present extent of mine drainage pollution in the North Branch of the Potomac Basin occurs within the reach upstream from Luke, Maryland in which acid conditions are most severe and mine drainage is the sole significant cause of pollution. The widespread occurrence of mine drainage in the north branch of the Potomac River inhibits the development of normal biological life in many of the tributaries streams as well as in the upper north branch itself. Over 45 miles of the north branch and over 100 miles of tributaries harbor virtually no aquatic fauna. Coal mine drainage affects water quality by the presence of sulfuric acid, iron and other dissolved minerals. These constituents inflluence water use in various ways -- the most dramatic effects are the destruction of fish and other aquatic life, impoundment of stream appearance, increased cost of water treatment, enhancement of corrosive properties, and associated sediment loads. Water containing mine drainage requires expensive treatment when used for municipal and industrial purposes. Iron and manganese are also present in concentrations which may require removal to satisfy some uses of this sub-basin.

F. THERMAL SOURCES

Cooling water demand for steam electric generation within the Potomac Basin has been estimated to reach as high as 14,200,000,000 gallons per day. Studies have indicated that future cooling water requirements in the Potomac River Basin in Virginia must be met from the tidal Potomac River or areas outside the Basin. Use of the Chesapeake Bay has been mentioned as a possible location for large power plants. The entire ecology of the Bay will probably have to be examined before designation of the Bay as a source for the large quantity of cooling waters anticipated in the future.

The close proximity of the VEPCO thermal discharge into the York River at Yorktown presents a potential thermal pollution problem which could adversely affect the water quality and marine life of the stream. A need for analysis of the effects of thermal discharges in the area is suggested.

The major threat of thermal pollution to the James River will result from additions to the VEPCO Chesterfield plant. The additional units will withdraw water from the main channel of the James River and discharge it into a manmade canal connecting with an old channel of the James which, in turn, runs into the main stream of the James.

The other major source of pollution will be from water use to cool the 2-unit nuclear power plant being constructed on Hog Island, the first unit to be completed in 1971.

G. RECREATIONAL AND COMMERCIAL NAVIGATION

In the lower estuaries of the major rivers within the Subregion, the discharge of sanitary waste from commercial and recreational watercraft has become a serious problem. Boating activity specifically in the lower James and Hampton Roads area is a major contributing factor leading to the degradation of water quality. This includes pleasure boats as well as commercial and government shipping. At present, there are twelve areas in the James River condemned by the State Health Department for the direct marketing of shellfish. These consist of 10,000 of a total of 41,000 acres of public and leased shellfish grounds. The condemned areas are located in parts of the James River, the entire Elizabeth River and its tributaries, part of the Nansemond River, and virtually all of the Pagan River.

One of the most serious pollution problems in the estuary is either directly or indirectly related to the oil industry in the area. Accidental oil slicks have resulted in large water fowl kills in marsh areas. Oil pollution resulting from accidental discharges from crude oil carriers has caused widespread damage including the killing of water fowl in the Lower York River. Other nuisance conditions are caused by pollution related to recreational and commercial boating activity in the estuary. At times, sanitary wastes are discharged intentionally by maritime vessels which dock at the American Oil Company pier in the York River below Yorktown. The principal pollution problems within the Lower Rappahannock Basin are localized are also related to boat pollution.

Bacterial pollution, partially attributable to waste discharges from vessels, has caused the Virginia and Maryland Health Departments to place restrictions on the direct marketing of shellfish taken from some beds in the estuarine portion of the Subregion. In addition to the bacterial pollution, the discharge of oil and other hazardous material from commercial vessels has been responsible for killing large numbers of waterfowl in recent years. These discharges have also diminished the recreational and aesthetic value of the water resources. In the period 1960 to 1966, 20 cases of violation of the Oil Pollution Act in the Norfolk, Virginia, area were investigated by the U.S. Attorney's Office.

Recreation demand for water related recreation is growing within the entire Subregion and carries an economic impact in resource development. Balanced water related recreation should be the general goal.

H. RURAL AND URBAN RUNOFF

Rural and urban runoff pollution enter the waters of the Sub-region from non-point sources. Most severe pollution problems from these sources result from urban runoff and combined sewer discharges in the Washington, D.C., and Richmond metropolitan areas. Nutrients, sediment, and pecticides are contributed from extensive farmland in the Subregion. Pesticides pose a significant, but unknown, threat to establish water quality. More definitive studies are needed to assess the magnitude and to define feasible alternatives for controlling this type of pollution.

I. OCEAN DISPOSAL

Ocean disposal is not a problem in this Subregion.

J. CONSTRUCTION ACTIVITIES

Erosion of land and the resulting sediment is a serious water quality degradation problem in certain areas of the Subregion. Sedimentation in rivers reduces navigability, impairs recreational usage, and hinders the development of marine life. Deposition within shipping channels makes dredging of these chemicals necessary. The subsequent disposal of the dredge material constitutes a threat to valuable wetlands and, when the dredged material contains organic and toxic substances, a pollution problem is created. Land under forest cover has a sediment contribution rate of roughly 100 tons/sq.mi./year; while for lands that have been disturbed by agriculture, urban development, and construction activities, the rate might be as high as 400 to 800 tons/sq.mi./year.

A number of methods are used to combat erosion and resultant deposition. Erosion of the land itself is controlled by proper farming methods and by protecting construction sites from runoff. Control measures may generally be divided among vegetative cover; the effectiveness of which is variable; and structural devices which often fail because of poor design or construction. Both structural and vegetative measures have been employed to combat erosion in the Subregion.

Corrective and preventive solutions to sedimentation, and soil erosion will likely take many years with the present technology to effectively lessen the erosion rate. Soil conservation practice, design of structures and land use controls are major devices which offer possible solutions to erosion and sedimentation problems. Both Federal and State agencies have the information and assistance needed to aid in the control of erosion where necessary studies can be made to determine or justify other alternatives. Erosion can be prevented through a program of education and applicable physical

measures. In addition to Federal and State programs, action by local communities will be essential if erosion and sedimentation problems are to be reasonably controlled. The sediment produced from land disturbed by mining operations in the upper region of the North Branch must be controlled through land reclamation and **revegetation** measures. Control of sediment pollution in the Monocacy River can effectively be made only through application of soil conservation techniques on the farmlands of the basin. The present benefit cost ratio of large-scale land treatment for erosion and sediment control make such measures economically unattractive.

VII - POLLUTION CONTROL ALTERNATIVES

A. SOURCE CONTROL

The most effective method of protecting the water quality of the Subregion is to prevent polluting material from entering the waters. This can best be achieved by the control of the pollutant at the source. Source control would be especially effective in preventing the formation and subsequent discharge of mine drainage pollution. It is estimated that from 20 to 70 percent of the mine drainage originating in this Subregion could be eliminated by appropriate preventive measures. The effectiveness of the preventive measure depends on the topography and geology of the area as well as the type of mining employed. Preventive measures which are generally applicable are restoration of surface drainage, mine sealing, surface sealing, recontouring, and reforestation of disturbed areas.

Probably the only feasible way to control non-point source pollution, such as rural and urban runoff, is by employing preventive onsite measures. Erosion control measures, such as crop rotation, terracing, and strip planting, have reduced soil loss by as much as 60 to 90 percent. Erosion depletes required plant nutrients from the soil, contributing significantly to eutrophication of surface waters throughout the Subregion. The problem is particularly acute in the upper James River and Potomac River estuaries. Prudent use of chemical fertilizers and pesticides coupled with adequate erosion control measures should substantially reduce pollution from these sources.

The volume and strength of waste produced in the manufacture of a product often depends upon the production process being used. notable example is the pulp and paper industry which is one of the major polluters in the Subregion. The acid sulfite pulping process used in older kraft paper mills relies on calcium bisulfite for the digestion of wood chips. This process does not lend itself to water reuse or chemical recovery. New mills are using either magnesium, ammonium, or sodium base bisulfite--all of which have the advantage of producing a spent liquor that is amenable to by-product recovery and water reuse. All industrial plants in the Subregion should be encouraged to re-examine their current manufacturing processes and employ measures to decrease waste production and increase water reuse. As new investments are made in manufacturing plants, they should be required to incorporate the most up-to-date manufacturing processes to accomplish this result.

B. TREATMENT ALTERNATIVES

Even with the implementation of feasible source control measures, there will still remain wastes that must be treated before they are discharged to receiving waters. The principal immediate need within

the Subregion is for the provision of adequate waste treatment facilities to control pollution at its source. There are 51, 8, and 35 sewage service areas in Areas 19, 20, and 21, respectively, that currently provide less than secondary waste treatment. All of these areas should provide a minimum of secondary treatment or 85 percent BOD_5 removal by 1980. Also, there are presently 15 major pollution sources in Area 19 and 6 in the other two areas of the Subregion where treatment levels in excess of secondary treatment will be required. These sources are:

Pentagon Arlington, Va. District of Columbia (Blue Plainsplant) Alexandria, Va. Fairfax County, Va. (West Gate plant) Charles County, Md. Fairfax County (Dogue Creek plant) Fairfax County (Little Hunting Creek plant) Fairfax County (Accotink-Pohick plant) Andrews AFB (Plant #1) Andrews AFB (Plant #4) Piscataway (Washington Suburban Sanitary Commission) Fort Belvoir (Plant #1) Fort Belvoir (Plant #2) Naval Comm. Station, Cheltenham, Md. Covington, Va. Lynchburg, Va. Hopewell, Va. Richmond, Va. Culpeper, Va. Fredericksburg, Va.

Low flow augmentation is a possible alternative to high level BOD removal for meeting water quality objectives. Both physical and economic factors must be evaluated in order to determine which alternative, or mix or alternatives, would be applicable to meet water quality objectives in each reach of watercourse.

With exception of the Washington Metropolitan area, water pollution problems are widely distributed in the Potomac River Basin and are readily amendable to conventional secondary treatment. Reservoirs have been proposed for several areas in the basin to provide supplemental flow for water quality control and for improvement of localized water quality conditions.

Present technological methods are not adequate for complete control of the effects of acid mine drainage. Except for mine drainage within the North Branch and the presence of nutrients in the Washington, D.C. area, the application of existing technology to water

pollution problems in the Potomac River Basin will provide for practical realization of present pollution abatement goals. New techniques are under development to cope with the acid mine drainage from the headwaters of the North Branch which have seriously polluted its waters. Desired water quality of the Potomac River cannot be assured on a year-round basis until discharges from combined sewers are controlled. This is a very complex problem which probably will require the expenditure of considerable sums to eliminate pollution from this source. The Washington Metropolitan complex is a rapidly growing area changing not only the character of the land use of the upper Potomac estuary drainage basin, but also places an increasing demand upon the water resources of the river and its estuary.

Studies by the Federal Water Quality Administration is 1969-1970, indicate that existing stream flows are generally adequate for projected water supply requirements in the upper estuary and in the upper James River Basin; exceptions to this are the industrial water supply needs at Covington, and the municipal needs at Charlottesville, Virginia. A combination of storage for low flow augmentation and waste treatment beyond secondary treatment (85% BOD removal) will be needed to maintain water quality standards in the Jackson River below Covington, and the James River below Lynchburg, and Hopewell, Virginia. Since eutrophication of the James estuary in the area of Richmond has caused serious water quality problems, nutrient removal may be a definite necessity in the future. Pollution problems resulting either directly or indirectly from combined sewers in the City of Richmond should be alleviated.

Needed water quality storage within the James River Basin will be provided im part by the proposed Gathright Reservoir to be constructed 19 miles above Covington, Virginia on the Jackson River. The multiple purpose reservoir under development by the Corps of Engineers will serve for water quality control of the critical stream section of the Jackson River for waste assimilation and maintenance of established water quality objectives during low flow conditions. Benefits of the proposed reservoir will extend into the estuary portion of the James River. The Gathright Reservoir Project is scheduled for completion in 1970. Additional storage will be desirable at sites either above Lynchburg if available, or on tributaries between Lynchburg and Hopewell after 1980. Most economical costs comparison between flow augmentation and advanced waste treatment is necessary for investigation.

Flow regulation to maintain water quality below Fredericksburg has been recognized as a potential need in the proposed Salem Church Reservoir. Various levels of advanced waste treatment in combination with flow regulation are being considered as possible solutions to protect the water quality of the Rappahannock Estuary below Fredericksburg. The Salem Church Dam, to be located approximately six miles upstream from the City of Fredericksburg, as planned by the Corps of Engineers, could provide for water quality control, water supply,

power, and recreation needs, if constructed. Present studies conducted by the Corps and other Federal/State agencies will determine the future course of this project.

C. STUDY NEEDS

In addition to the North Atlantic Water Resources Study, there are a number of interagency water resources studies being conducted which include all or portions of Subregion F. The major ones are the Appalachian Regional Water Resources Study and the James River Basin Interagency Study. Most of these studies are schedules to be completed in Fiscal Year 1971.

The data collected during the course of these studies should form a firm basis for defining current water quality control needs and to establish a workable framework for meeting future needs. The officials of the various states within the Subregion are acutely aware of the water quality and pollution control needs within their respective jurisdictions and are striving earnestly toward their solution.

Other than detailed water quality and resource studies which have been conducted for the Potomac River in the Washington Metropolitan Area, water quality information and resource development within the Subregion is largely fragmentary and confined to a particular problem or location. There are serious data gaps in basic knowledge particularly for water quality problems in Area 20. Waste inventories are incomplete, water sampling data is for localized areas, and the long-term effects of such pollutants as nutrients and heat are unknown.

The major pollution control problems in the Subregion which will require additional study are:

- Mine Drainage What is the most feasible method of treating the pollution? Who is legally and fiscally responsible for abating the pollution from inactive and abandoned mines?
- 2. Nutrients What is the threshold level for nutrient pollution, and what are the most feasible methods of achieving nutrient control?
- 3. Thermal Pollution What are the long-range effects of thermal discharges?
- 4. Chesapeake Bay Relationship How will the flow regulation and waste discharges within the Subregion affect the hydrology and ecology of the Chesapeake Bay?
- 5. Financial Impact What capability exists for paying for water resource programs, and what will be the financial impact of such programs?

There are more than 1,450 known studies which deal with the Chesapeake Bay. However, these studies are incomplete and none deal with the overall problems of the Bay. In 1965, the Corps of Engineers was authorized to perform a comprehensive avaluation of the entire Chesapeake Bay. The construction of physical model of the Bay was included in the authorization. Due to the lack of funds following authorization, little progress was made on the study. However, the study is now being funded and the final design of the model is nearing completion. Because of the complex nature of the Bay, a physical model will provide a valuable tool to observe and analyze many interrelated factors affecting the Bay. The advent of high speed computers will allow the application of mathematical modeling techniques to supplement the physical model. Some of the specific needs to which a study of this kind should address itself are:

- 1. Conduct studies to determine the source and amount of nutrient introduced to the Bay and the current level of euthrophication in the Bay.
- 2. Complete municipal and industrial waste source inventory.
- 3. Develop a data gathering and data retrieval system for the entire Bay.
- 4. Evaluate the effect of projected waste discharges on the water quality of the Bay through the application of mathematical modeling techniques.

The overall study needs within the Subregion include comprehensive basin-wide cooperative surveys by Federal and State governments to determine assimulative capacities of existing and proposed water receiving streams and to provide necessary data for evaluation of present or potential pollution control needs. These studies should include intensive water quality studies of the estuaries, measures for minimizing bacteriological pollution in shellfish bed areas, and determination of the effects of thermal discharges on water quality. The recommended studies should result in the development of basin-wide comprehensive water pollution abatement programs and a mathematical assimilation of major river systems including the Chesapeake Bay and its tidal tributories.

D. OTHER NEEDS

1. Legal

Legal needs exist for adoption and uniform enforcement by appropriate regulatory agencies of effective ordinances for control of soil erosion especially in the Washington, D.C. area. Development of uniform regulations and laws for control of pollution from watercraft is also necessary. Present laws and regulations governing

Watercraft pollution in the Subregion are nonexistant or ineffective.

2. Manpower

As is true in other subregions in the NAR area, the need in Subregion F for well-trained personnel to operate the required treatment facilities in acute. The ability of a treatment facility to achieve design efficiencies is dependent upon the skill and knowledge of the operator. Enhancement of treatment plant operator efficiency can best be made by proper emphasis on operator training schools and State certification programs.

3. Research and Development

The most pressing research and development needs specific for Subregion F are (a) to find a feasible and economic way to prevent or otherwise eliminate mine drainage pollution, (b) to reduce and control the pollutional aspects of land runoff and wet weather overflows from combined sewer systems, (c) to develop reliable and effective methods for increased organic and nutrient removal from wastewater, and (d) to better define the threshold limits and ultimate effects of eutrophication in the estuary portion of the major rivers of the Subregion and the Chesapeake Bay. The other research and development needs discussed in Chapter I of this Appendix generally apply to Subregion F.

4. Public Support

In the final analysis, the residents of the Subregion must decide what use is to be made of their resources. Whether or not the decision they reach is in the best interest of the majority of the residents depends on how well they are informed of the relevant facts concerning the environment and the consequences of their decision, or indecision. In studies like the NARS, and in subsequent studies, every effort should be made to keep the public informed, to stimulate their interst, and to enlist their support for water resource planning and development. The environment, from which everyone in the Subregion derives his existence, has been or is being destroyed by improper utilization. Much of the past damage has been allowed to occur because of public apathy or the shortsighted desire for quick and easy monetary gain. Many of the environmental problems we now face in Subregion F are the result of past industrialization and neglect. the planning and actions we take today, we must insure that similar changes cannot be leveled at our efforts. The public must be made aware of the impending environmental problems that are threatening their water resources. The desires of the public, as expressed through their elected representatives, will help shape the course of water resource and environmental development in the Subregion. For the preservation and wise use of the Subregion, it is essential that some broad public objectives be involved and that effective government coordination be achieved. Protection of the water quality and

resources within the Subregion requires the continuing coordination of communities, landowners, and official agencies.

The Potomac River, more than any other, is a focal point of the American conscience in water quality control and it has been the subject of extensive study for various purposes. The nationwide attention focused upon the Potomac River Basin requires that the water of the mainstem and most of the tributaries be maintained at the highest feasible quality. The state of waste treatment technology is such that these goals can be achieved if there is a willingness to bear the high cost of providing the necessary levels of treatment. The Potomac River can be a model for water quality control of all the rivers of the Nation and can be managed for the benefit of all users to provide fishing, swimming, and other recreation, ample municipal and industrial water supplies, and at the same time assimulate adequately treated domestic waste from the rapidly expanding pollution.

5. Financial

Estimates of the financial investment required for water quality control in Subregion F have been prepared for the design years 1980, 2000, and 2020, and are presented in Table F-9. These costs represent the capital investment that would be needed to build secondary and advanced wastewater treatment facilities capable of treating projected waste loads for the target years. In practice wastewater treatment facilities are sized to accommodate the projected growth in waste load over a 20- to 25-year economic plant life. Projected population growth together with actual timing of plant construction, rate of physical obsolescence, and salvage value will determine actual expenditures over the study period. Operation and maintenance costs and the cost of waste collection systems and sludge disposal facilities are not included in the cost estimates. The cost presented in Table F-9 should serve only to indicate the order of magnitude of the financial investment needed in Subregion F for water quality control and to serve as a common base for comparison with other Subregions. They are not intended to replace estimates developed as a result of detailed engineering studies for specific municipalities or industries.

TABLE L-9(F)

PROJECTED CAPITAL COSTS OF WATER QUALITY CONTROL^a/

SUBREGION F

Estimated	Estimated Addi-	
Secondary b/		a.1 a.d/
Treatment—	Treatment 27	Other Cost ^{d/}
	Planning Area No. 19	
360,000,000		
640,000,000		
1,081,000,000		
	Planning Area No. 20	
58,300,000		
126,800,000		
333,132,000		
	Planning Area No. 21	
495,000,000		
1,120,000,000		
2,420,000,000		
	Cost of Secondary b/Treatment / Treatment / Treatment / 360,000,000 640,000,000 1,081,000,000 126,800,000 333,132,000 495,000,000 1,120,000,000	Cost of Secondary Advanced Waste Treatment Planning Area No. 19 360,000,000 640,000,000 1,081,000,000 Planning Area No. 20 58,300,000 126,800,000 Planning Area No. 21 495,000,000 1,120,000,000

- <u>a/</u> For general purpose planning only. Based on 1960 dollars. Costs not to be applied to any individual situation.
- <u>b</u>/ Based on treating organic waste loads of both industrial and domestic origin.
 Treatment is considered to be 85 percent removal for the year 1980 and 90 percent for the years 2000 and 2020.
- <u>c/</u> Treatment which would remove, in addition to 95 percent Biochemical Oxygen Demand and 98 percent suspended solids, up to 98 percent of nutrients and up to 95 percent of other materials not removed by conventional treatment methods.
- d/ These costs are, where known, estimates for combined sewer overflows control.

VIII - POLLUTION CONTROL PROGRESS

A. STATE

The State officiels of the Subregion are aware that the waters of the Subregion are a valuable, though not inexhaustable, resource; and that these resources must be protected and developed in order that present and future requirements will be met. All of the States in the Subregion have established interstate water quality standards and have developed an implementation plan for achieving these standards. Four states (Maryland, West Virginia, Pennsylvania, and Virginia) have also established standards for the major intrastate streams.

Recognition and concern for the seriousness of mine drainage pollution has led to enactment of the Abandoned Mine Drainage Control Act of 1970. House Bill 1094 by the Maryland Legislature. The legislation provides funding of \$5 million to defray capital cost of the prevention, control, and abatement of pollution from abandoned mines, and to acquire land affected by such pollution. Montgomery County and Prince Georges County, Maryland, Fairfax County, Virginia, and the District of Columbia, have adopted ordinances for the control of soil erosion. The effectiveness of these programs for control of soil erosion is being evaluated. The Virginia Legislature has recently approved changes in the State pollution control law and allocated \$7.8 million in funds for the matching Federal grant program for pollution abatement within the State. The Virginia Commission of Outdoor Recreation has proposed legislation to establish a scenic river system in the State. Enactment of the legislation together with completion of reservoir planning activities should have a profound effect on present and future water resource development and management in Virginia.

B. FEDERAL

The Water Quality Act of 1965, as amended, contains the authorization for Federal involvement in efforts to eliminate pollution and enhance water quality in the interstate waters of the Nation. In compliance with stipulations of the Act, all the States in the Subregion have submitted water quality standards which have been approved by the Federal Government. Also, the Act established the mechanism through which the Federal Government would share in the cost of financing treatment facilities. As of December 1970, over 500 waste treatment plants in the Subregion received some \$87.4 million in Federal grants for renovation, expansion or new construction.

C. STATE AND FEDERAL

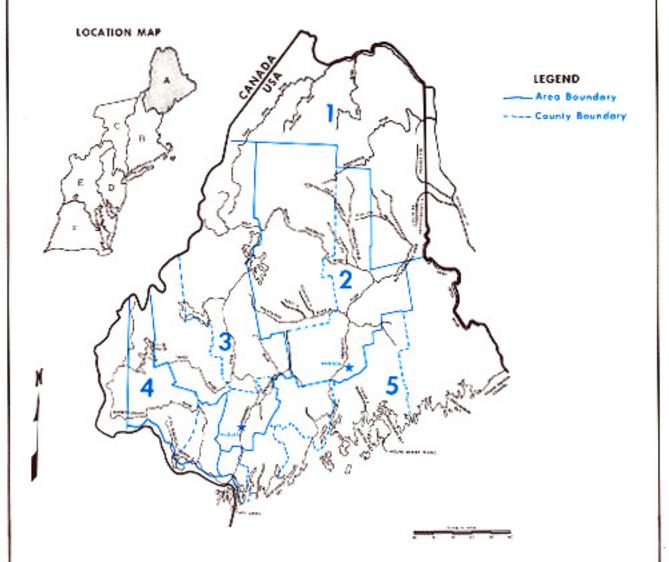
A number of comprehensive water resource studies are either in process or planned involving both State and Federal efforts. of the Chesapeake Bay has been hampered by the lack of adequate funding; however, funds are now available and the study is underway including the construction of a physical model. The model will provide a valuable tool to analyze certain phenomena taking place in the Bay. In January 1971, the Congress of the United States approved the Susquehanna River Basin Compact, and was signed by the President creating the Susquehanna River Basin Commission. The mechanism established by the Compact should provide an effective means by which water resource development in the Susquehanna River Basin will proceed in an orderly and productive manner. A similar Compact, to provide a comprehensive mechanism of the water resources of the Potomac River Basin, has been approved thus far by Maryland and Virginia. This Compact will also require the approval of West Virginia, Pennsylvania, and the Federal If the Compact becomes a relatively, it, like the Susquehanna Basin Compact, will be another basis for Federal/State cooperation in the development of water resources of the Basin.

The Third Session of the Potomac River-Washington Metropolitan Area Enforcement Conference in 1969 and subsequent progress evaluation meetings resulted in limitations of organic and nutrient waste discharge levels and accelerated construction schedules for a total of 15 municipal, industrial, and Federally-owned waste treatment facilities now discharging to the Potomac River and tributaries in the Washington, D.C. area. The waste load allocations established for the Potomac River in the Washington Metropolitan Area are, however, subject to alteration by flow augmentation from upstream reservoirs. Recommendations of the Enforcement Conference also dealt with measures for control of soil erosion, debris and litter wash, and establishment of cooperative surveillance programs for stream monitoring and treatment plant effectiveness and oil pollution between Federal and State water pollution control agencies. A study was completed in 1970 by the District of Columbia in cooperation with EPA and PEPCO (Potomac Electric Power Company) to evaluate the effects of heated water on the Potomac and Anacostia Rivers and report results together with recommendations for any required corrective actions. Another study presently being prepared by the Environmental Protection Agency in cooperation with State, interstate, and local agencies will deal with alternate methods of meeting future water quality requirements and needs in the Washington Metropolitan Area. The study was scheduled for completion in January 1, 1971.

Since 1960, significant improvement in waste disposal practices throughout the Basin have resulted from increased awareness of pollution hazards at the local level, stricter control of pollution of State levels, publicity regarding water pollution problems by INCOPOT, and the strengthening of the enforcement and grants programs at the Federal level. A general improvement of water quality within the

Potomac River has resulted above tidal waters. The upper estuary near Washington, however, is as seriously degraded as it was during the last decade.

- 1. TO JOHN BYEE, MANA 2. PRINCESCOT BYEE MAINS
- 3. KENNIEGE RIVER, MAINE 4. ANDROSCOGGIN BIFER, MAINE AND NEW HEMPSHIRE.
- S. SI. CROIX HITH. WAINS AND ATLANTIC COASTAL AREA FROM THE INTERNATIONAL ROUNDARY TO CAPE SMALL, MAINL

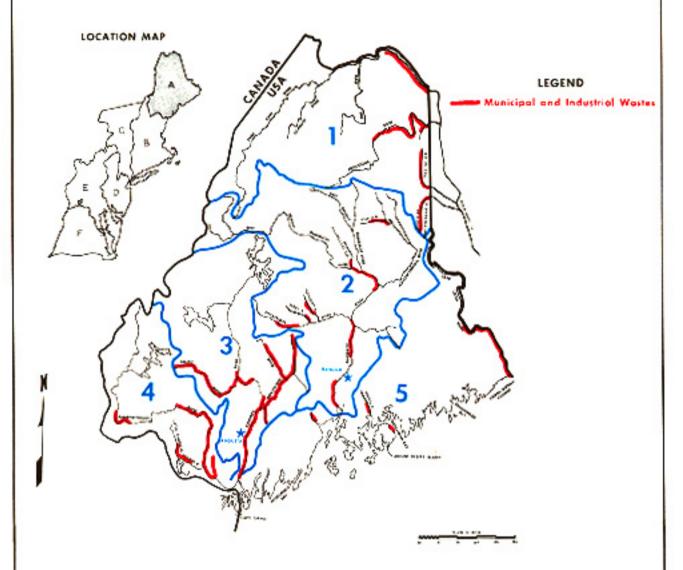


SUBREGION A Areas 1,2,3,4 and 5

LOCATION AND BOUNDARIES

IMPCA December 1964

- 1 St. John Style Mark! S. FENDESCO Sover, Mark! S. Enneste Birts, Mark! 4. ANDESCOGGER KYNE, MARK AND NEW HAMPSHIE!
- 5 51 CROIR BINCE, MAINE AND ATLANTIC COASTAL AREA FROM THE INTERNATIONAL BOUNDARY TO EAST SMALL MAINS.



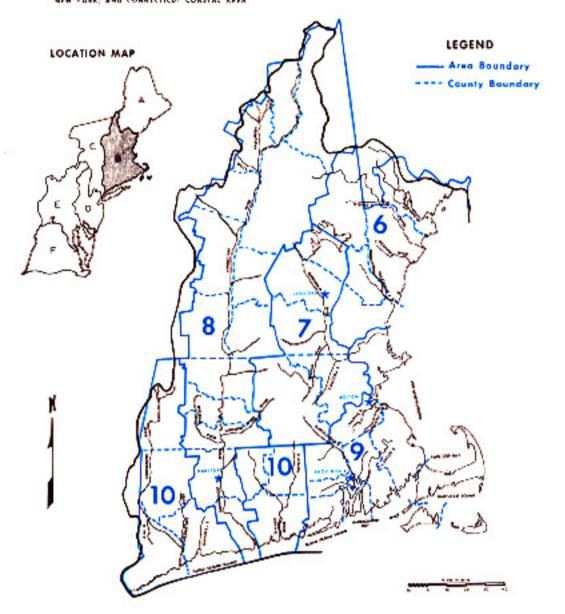
SUBREGION A Areas 1,2,3,4 and 5

WATER QUALITY PROBLEM AREAS

PAPCA December 1959

- E SEISUMPICOS BIVES, MAINS, SACO SIVES, MAINE AND NEW HEMPINIES; PERCETAGUE ENTE, NEW HEMPENIES ENG MAINS, AND AFLANISC
- CONSTRUCTOR OF THE TANKS AND THE TO NOW MANAGEMEN MATTER OFFICES STATE LAW
- P. COMMICTION BYEER, MERCANDER AND MACESCAPHICE MASSAGE AND COMMICTION.

 P. MARRAGANSITE BAS DESIRED. MASSACHUSTIS AND SHOOL MICHAEL PROPERTY. SHOPE SHAND AND COMMICTIONS AND ANAMATIC COMMISSIONS NEW HAMPSHIEL MASSACHUSTIS STATE LIME TO SHOOL MISSAGE COMMISSIONS STATE SHAND. THAMPS SIVER, COMMISSIONS MASSACHUSTIS AND SHOPE SHOPE, COMMISSIONS MASSACHUSTIS AND MEW FORK, AND COMMISSIONS COMMISSIONS MASSACHUSTIS AND MEW FORK, AND COMMISSIONS COMMISSIONS MASSACHUSTIS AND MEW FORK, AND COMMISSIONS COMMISSIONS COMMISSIONS MASSACHUSTIS AND



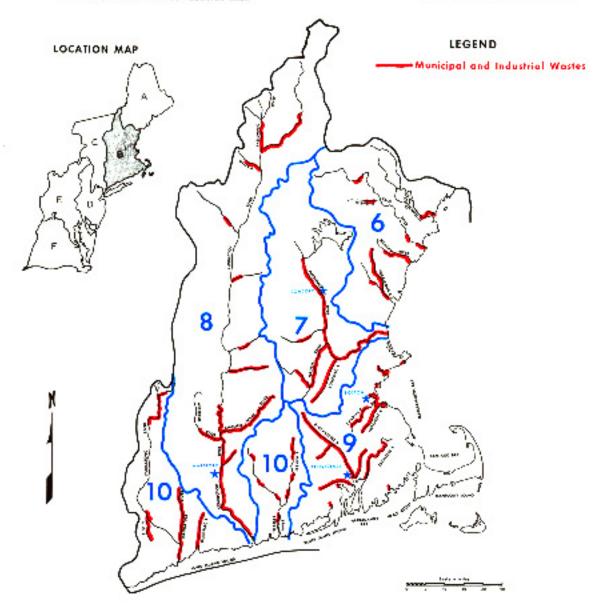
SUBREGION B Areas 6,7,8,9 and 10

LOCATION AND BOUNDARIES

- C PRISUMPSCOT RIVER, MAINE- LECTI BINTE, MAINE AND HEW HAMPSHIRE, PISCRIAGUA BINTE HEW HAMPSHIRE AND MAINE; AND AFLANTIC FOREIGNES BIVER, NEW HEMPSHIEC AND MASSACHUSETTS STATE LINE.

- A MERINACK BIVER, MIN MANASHIRE AND MASSACHUSELIS AND CONNECTION.

 9. HABBACTANETT BAY DER MASSACHUSETT AND RHODE ISLAND. PAMICATURE BIVER, ENOUS ISLAND AND CONNECTION AND AND CONNECTION AND ATLANTIC COASTAL AREA FROM HEW HEMPERIET, WASSACHUSETTS STATE LINE TO ENGINE ISLAND AND CONNECTION STATE LINE IS. THE BIVER, CONNECTION. MASSACHUSETTS AND PHODE ISLAND, HOLSATONIC BIVER, CONNECTION. MASSACHUSETTS AND MEM 100K, AND CONNECTION COASTAL AREA.



SUBREGION B Areas 6,7,8,9 and 10

WATER QUALITY PROBLEM AREAS



W YORK CITY ICAG GLAND AND MYSICHETER COUNTY COASIAL ASIA.

ANADA LEGEND Area Boundary -- County Boundary LOCATION MAP

SUBREGION C Areas 11,12 and 13

LOCATION AND BOUNDARIES

INFCA December 1944

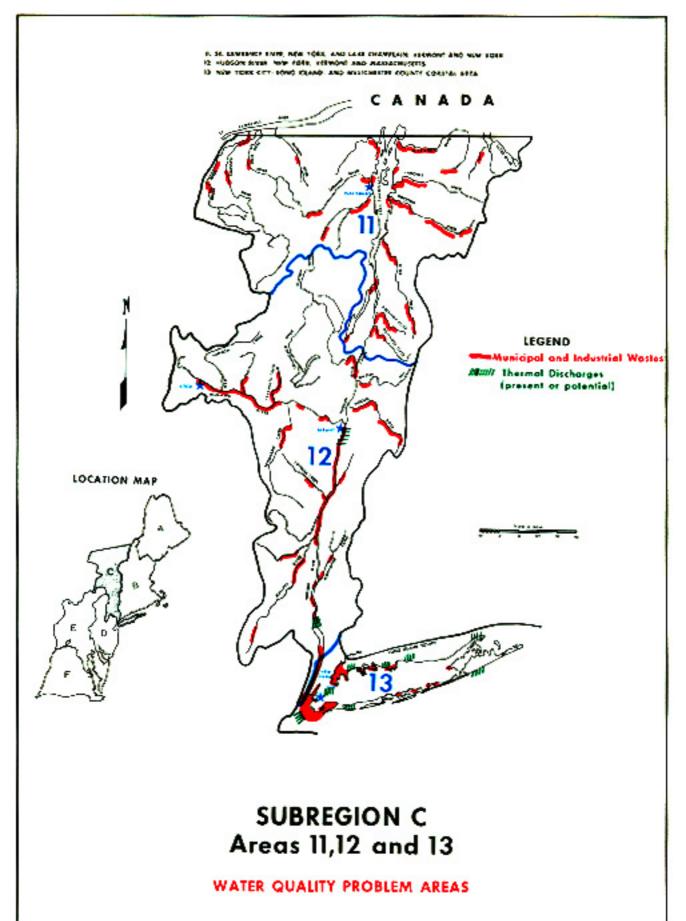
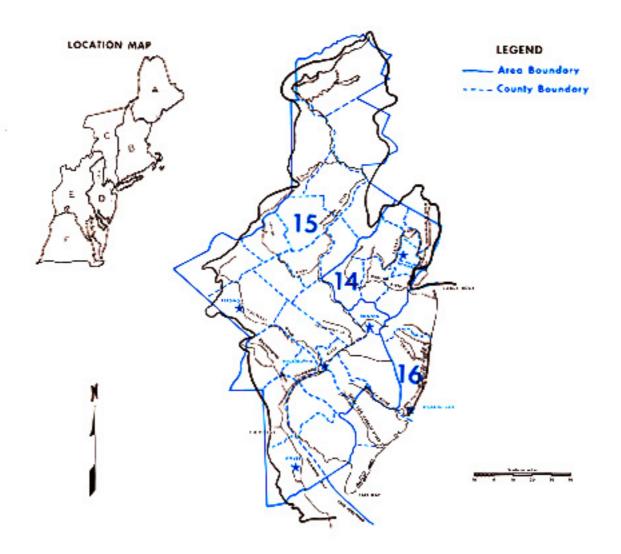


Figure C-2

PMPCA December 1944

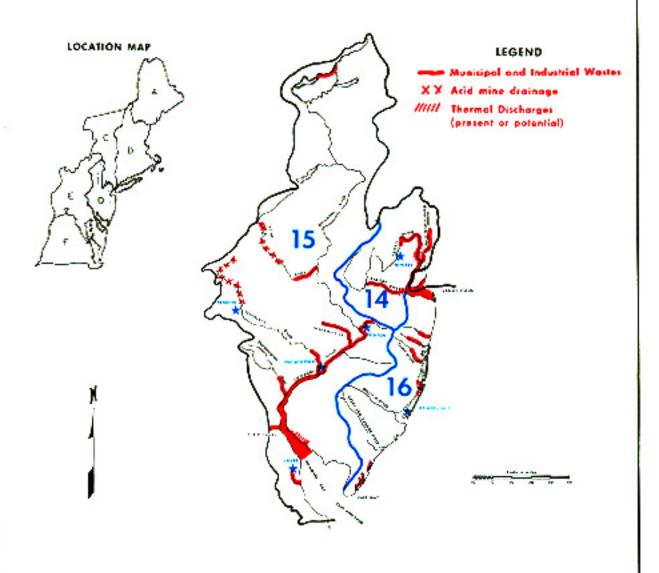
- se factor fives, new 1830's and new 1966, bashan civic new incert and office necessary research is excample before and delegates new new 1966, new 1830's Tennsylvania and delegates. Is allowed; commendates from rends hook new 1830's To Carl Mat, new 1830's.



SUBREGION D Areas 14,15 and 16

LOCATION AND BOUNDARIES

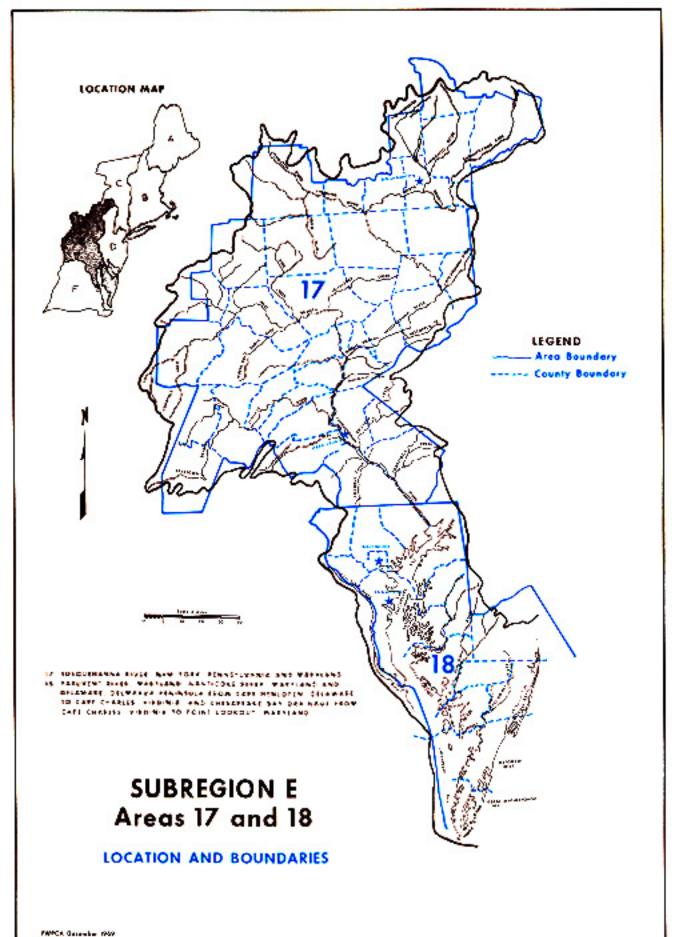
THE PARKER BLUES, NEW MESET AND NEW YORK, BARTAN KINIK, NEW MEETS, AND OFFICE MOCKHIGH HEW MESET STREAMS. TO OFFICE CLARK AND CHEMMAES NAT, NEW YORK, NEW MESET, PENNSTLYAMIA AND THEMASE. TO AFFINITY CONSTAIL NEED FROM BANDS WORK, NEW MESET TO CAPI WAT, MITW MESET,

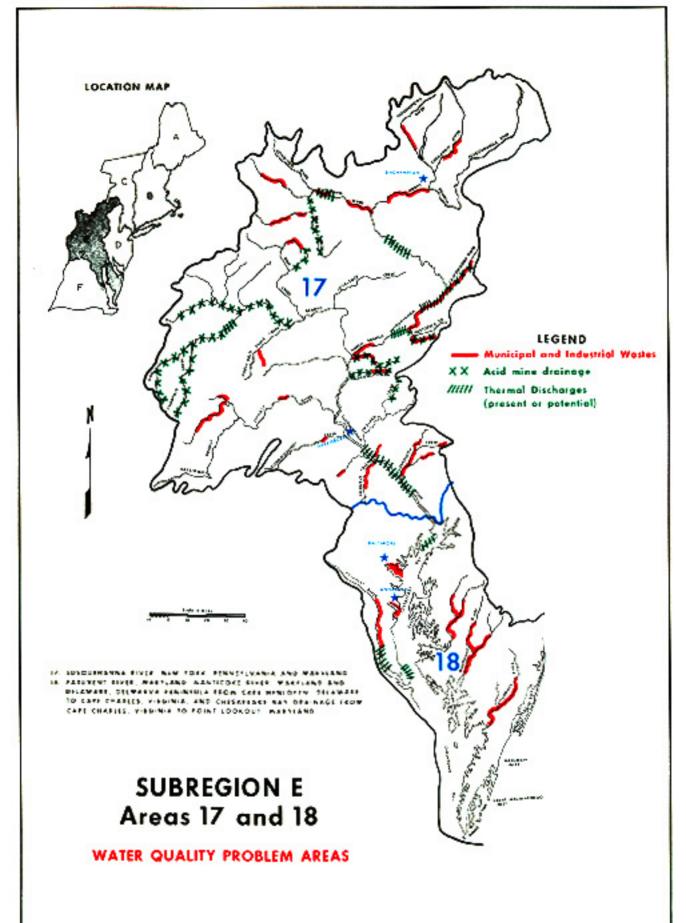


SUBREGION D Areas 14,15 and 16

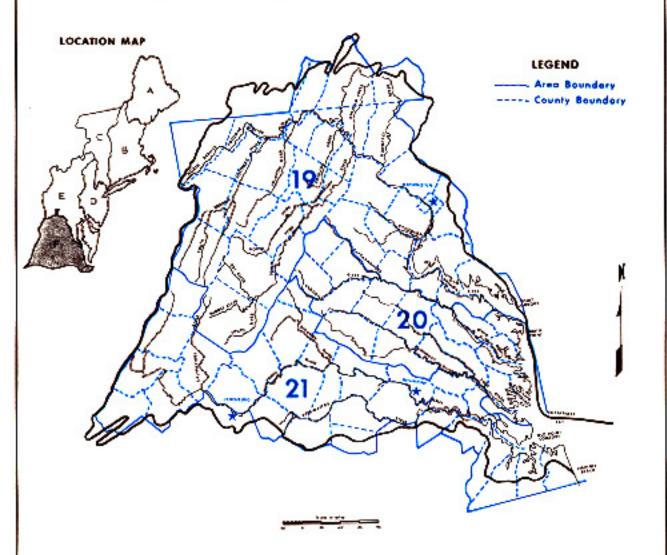
WATER QUALITY PROBLEM AREAS

PAPCA Garantes 1969





- IN PORGMAC PINTE, MARYLAND, YIRDINIA, WIST MAGINIA, PHINETIYAMIA AND MARYLAND.
- TO BUT FOUND CONCERN VERSIONS FOR STORE WINGINGS, AND CHESTOFICARE BAY DRAININGS FROM SWITH FOUND, VIRGINIA
- TO DID FOIRI COMPORT, VIRGINIA 71 JAMES BIVES, VIRGINIA AND WIST VIRGINIA, AND CHISAPCAKE DAY AND KNAMES SHAFFEL SPANNAGE IROW, OLD ROTHS COMPORT, VIRGINIA TO VIRGINIA SPACE WISTOMIA.



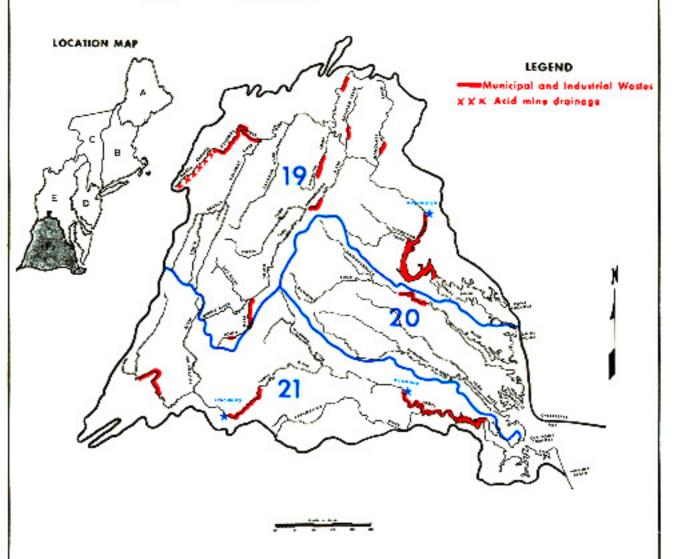
SUBREGION F Areas 19,20 and 21

LOCATION AND BOUNDARIES

PAPER Grounder 1969

- W. FRIRMAC STARE, MARYLAND, MAGINIA, WHAT MARRIA, MARYLMANA, AND MARYLAND,
- 10. PAPPAHAMOOK RIVER, VIBUING- FORK BYES, VIRGINIS LAND OILSAPIARE BAY DRIVARE 196M CHIIN FORC. VIRGINIS
- 16 OLD POINT COMPTRE, VIRGINIA.

 11. JAMPA BIVES, VIRGINIA AND WISH VIRGINIA, AND CHEARPARKS BET AND SITURNIC COASTAL GRAMATIP ISON OLD POINT COMPOST, VINGINIA TO VIRGINIA STACK, VIRGINIA.



SUBREGION F Areas 19,20 and 21

WATER QUALITY PROBLEM AREAS

PAPCA December 1969

